D2.3 Circular construction skills qualification framework

Compiling a task-based qualification framework for general circular skills in the construction value chain

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Publishable executive summary

Within the BUS-GoCircular project, a **general task-based qualification framework** was developed for **circular skills in construction**, meaning a set of tasks and corresponding learning outcomes were mapped and connected to relevant professions throughout the construction value chain. By doing so, the project offers a practical interpretation of the *Key Elements of the Circular Economy*, made applicable to the construction sector.

Results consist of two tables. The first contains tasks and subtasks; the 9 tasks are the practical equivalents of the *Key Elements*, and the 60 subtasks further specify strategies to implement circularity in construction. These subtasks are connected to professions on the one hand, and so-called Units of Learning Outcomes (ULOs) on the other. The second table specifies the 80 ULOs. This segment of the results states the specific learning outcomes one should reach if circular strategies are to be implemented. They are broken up into competencies, skills, and knowledge components.

The methodology that was employed to establish these results, has been developed and validated throughout several previous (and ongoing) large-scale European projects. It has several advantages, one of which is the practical perspective it offers on required skills in the value chain, and required overlaps between actors.

The qualification framework results were developed with the use of various inputs. The main foundation of the work is the *framework for circular interventions*, which was previously compiled in the BUS-GoCircular project. Other resources were also used to ensure that circular skills for renewable energy sources, energy efficiency, and digitalisation were included.

Next steps for the general qualification framework for circular construction skills, are firstly for the work to be validated by market stakeholders. Then, it will be used within the BUS-GoCircular project to develop train-the-trainer and mentoring programmes for circular construction skills in Europe. In the near future, learning outcomes from the framework will also be added to the BUILD UP Skills Advisor app, to further increase skills recognition for professionals and craftsmen.

List of acronyms and abbreviations

ULO: Unit of Learning Outcome

EE: Energy Efficiency

EQF: European Qualification Framework

RES: Renewable Energy Sources

KE: Key Elements

BIM: Building Information Modelling

RFID: Radio Frequency Identification

VOC: Volatile organic compound (emissions)

Definitions

Building stages & RIBA: A building life-cycle consists of several stages. The RIBA Plan of Work is the definitive UK model for the building design and construction process.

Circular economy: The circular economy offers the next progressive step in our economic model, taking over from the current linear 'take-make-waste' economy by seeking to extract the maximum value from resources in use and keep materials in circulation for as long as possible through processes like reuse, repair, remanufacture and recycling. The ultimate goal of a circular economy is to establish an ecologically safe and socially just operating

Competence: The ability of an individual/organisation to do something effectively.

It consists of a cluster of attitude, related abilities, commitments, knowledge, and skills that enable a person (or an organisation) to act effectively in a job or situation.

The competence description is always worded as a result somebody can take responsibility for. Competence addresses 'responsibility and autonomy'. It is the ability of the learner to apply knowledge and skills autonomously and with responsibility.

European Qualification Framework (EQF): Common European reference framework with the purpose of making qualifications more readable and understandable across different countries and systems. (COUNCIL RECOMMENDATION of 22 May 2017 (2017/C 189/03))

Key elements framework: The Circle Economy Key Elements (KE) framework is a conceptual framework of eight elements of circularity that can be applied at different intervention levels (for example, national, regional, sector, business, product, process, or material) towards a circular economy. The KE framework consists of three core elements and five enabling elements. Core elements deal with physical flows directly, whilst enabling elements deal with creating the conditions or removing barriers, for a circular transition[1].

The three **core key elements** are:

1. **Prioritise regenerative resources:** Ensuring that renewable, reusable, non-toxic resources are used in the manufacturing of built environment. Ensuring that all resources are used in an efficient way.

[1] Circle Economy, 2021. https://www.circle-economy.com/resources/the-key-elements-of-the-circular-economy-framework

2. Preserve and extend what is already made / Stretch the lifetime: While resources are in-use, maintain, repair and upgrade them to maximise their lifetime and give them a second life through take back strategies when applicable.

3. Use waste as a resource: Utilise waste streams as a source of secondary resources and recover waste for reuse and recycling.

The five **enabling key elements** are:

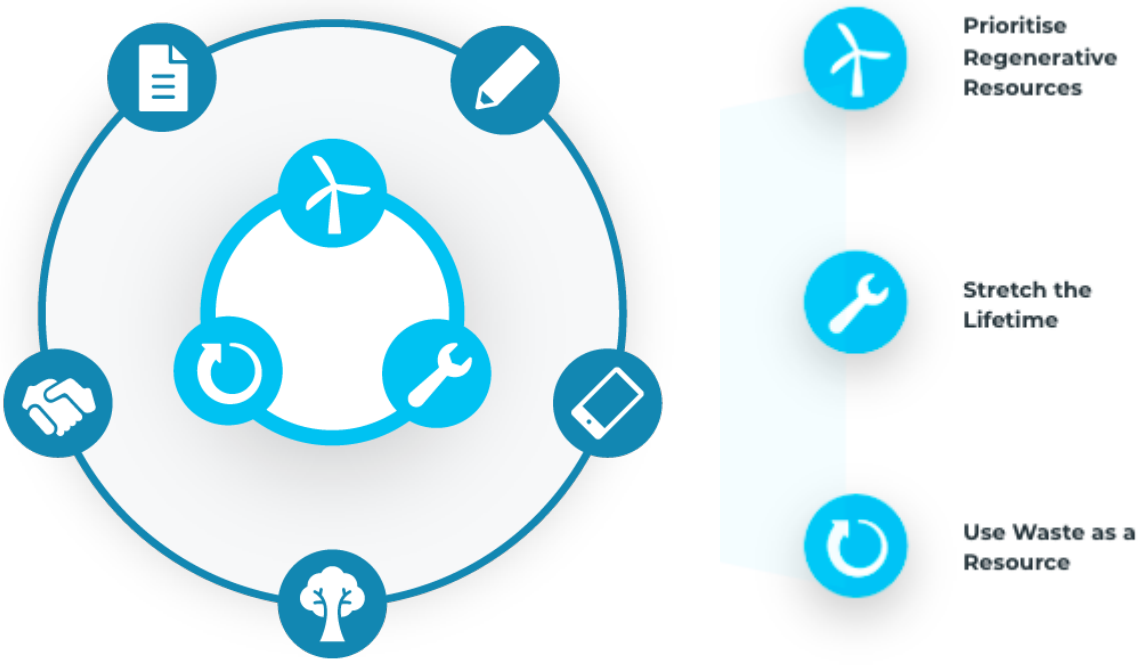
1. Design for the future: Account for the systems perspective during the design process, to use the right materials, to design for appropriate lifetime and to design for extended future use.

2. Collaborate to create joint value: Work together throughout the supply chain, internally within organisations and with the public sector to increase transparency and create joint value.

3. Rethink the business model: Consider opportunities to create greater value and align incentives that build on the interaction between products and services.

4. Incorporate digital technology: Track and optimise resource use and strengthen connections between supply chain actors through digital, online platforms and technologies that provide insights.

5. Strengthen and advance knowledge: Develop research, structure knowledge, encourage innovation networks and disseminate findings with integrity.



Knowledge: 'Knowledge' is the body of facts, principles, theories, and practices that is related to a field of work or study.

Know-how you need to know by 'head' in order to perform a task as efficiently and effectively as possible.

In the context of the EQF, knowledge is described as theoretical and/or factual.

Profession: A profession is a specialised occupation characterised by profession specific education and training.

Qualification: A pass of an examination or an official completion of a course, especially one conferring status as a recognized practitioner of a profession or activity.

Skill: Something a person needs to be able to do/perform in order to reach a certain result.

To have a 'skill' or to be 'skillful' signifies the ability to use know-how to complete tasks and solve problems. These can be cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

Ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

Subtask: An activity that is part of a certain task at a subordinate level. Individual subtasks can be linked to multiple tasks.

Task: A piece of work / an activity to be done or undertaken.

Task-based qualifications A qualification framework in which tasks and subtasks are set up and connected to a) relevant professions and b) learning outcomes in the specific form of Unit of Learning Outcomes

Unit of Learning Outcome (ULO): The 2008 EQF recommendation defines learning outcomes as '…statements of what an individual should know, understand and/or be able to do at the end of a learning process'. ULO's are statements regarding what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and attitude (reflected in responsibility and autonomy).

Table of Contents

List of Figures

List of Tables

1. Introduction

In the built environment, a lot can be done about the major contributions of the sector to environmental degradation. A circular approach to construction, from planning and design to end-of-life, can reduce much of the energy consumption, greenhouse gas emissions, use of extracted materials, and the amount of waste generated by the built environment. By carrying out circular economy interventions throughout each stage of the construction value chain, environmental impact and life cycle costs can be lowered, and resource depletion can be prevented.[2] In addition, local environmental impacts can be reduced, such as nitrogen surpluses, stress on nature and biodiversity, and pollution.[3]

Figure 1. The *Key Elements of the Circular Economy* in the context of BUS-GoCircular.

Within BUS-GoCircular, a *general circular construction skills qualification framework* has been developed. The current deliverable explains the results of this development. In the

[2] BUS-GoCircular D2.1 Framework for circular interventions in the construction value chain. https://busgocircular.eu/framework-for-circular-interventions-in-the-construction-value-chain/

[3] Trinomics, 2018. Quantifying the benefits of circular economy actions on the decarbonisation of EU economy: Final report. http://trinomics.eu/wp-content/uploads/2020/04/Trinomics-2018-Quantifying-the-benefits-of-circular-economy-actions-on-the-decarbonisation-of-EU-economy_final-report.pdf
Circle Economy, 2021. Three ways circular construction can strengthen biodiversity efforts. https://medium.com/circleeconomy/three-ways-circular-construction-can-strengthen-biodiversity-efforts-bfc632061715

framework, tasks that are required for ensuring circularity in construction are mapped and connected to a) corresponding professions and b) corresponding learning outcomes. This will give hands-on insight into who needs to develop which competences, to be able to create a circular built environment.

The generation of the general circular construction skills qualification framework has multiple purposes. Firstly, within the BUS-GoCircular project, the qualification framework will be used as input for setting up the Train-the-Trainer- and mentoring programmes, as well as the fundamentals training packs (See Figure 2). Second, the qualification framework will be used for extending the BUS-Advisor app, enriching skills repositories, and connecting skills and skill sets to relevant upskilling and eLearning opportunities. The availability of a set of general qualifications for circular construction can be used for reaching recognition of skills across countries. In order to test the applicability of the framework to specific fields in construction, it will be applied to the subject of multifunctional green roofs, façades, and interior elements.

Earlier in the BUS-GoCircular project, the consortium established a *Framework for circular interventions in the construction value chain*.[4] This was a research and gathering of opportunities for circular approaches that can be applied to the built environment. The *Key Elements of the Circular Economy* framework[5] had guided the investigation, with its three 'core elements' and five ‘enabling elements' (See Figure 1). Both the framework for circular interventions, and the key elements framework, have guided the work that is to be elaborated upon in the current deliverable.

First, the *general circular construction skills qualification framework* will be presented in two tables. These are the results.Second, the approach for development of the qualifications is elaborated upon, including more information about the methodology, previous applications of the methodology, and added value. This paragraph also explains what resources have been used as knowledge input for the qualification framework. Third, insight is provided into the process of developing the qualification framework within the consortium. It is also explained which important decisions have been made. Lastly, the deliverable mentions future

[4]BUS-GoCircular D2.1 Framework for circular interventions in the construction value chain. https://busgocircular.eu/framework-for-circular-interventions-in-the-construction-value-chain/
[5] Circle Economy. Key elements of the circular economy. https://knowledge-hub.circle-lab.com/circular-jobs-initiative/frameworks/9?n=Key-elements-of-the-circular-economy

developments and applications of the BUS-GoCircular *general construction skills qualification framework.*

Figure 2. Objectives of the BUS-GoCircular project.

2. Results

By using the methodology of developing task-based qualifications, and employing the *Framework for circular interventions* as a main foundation, the circular construction skills qualification framework has been developed. The qualification framework consists of a list of 9 tasks with subtasks. Each subtask is linked to corresponding Unit of Learning Outcome (ULO) numbers and relevant professions. This information can be found in Table 1. The 70 Units of Learning Outcomes (ULOs) are written up in Table 2. The structure of the full framework is depicted in Figure 3 and 4. ULOs, then, consist of a set of competences, skills, and knowledge components (See Figure 5). The full names of professions that are referred to in Table 1 can be found in Appendix I.

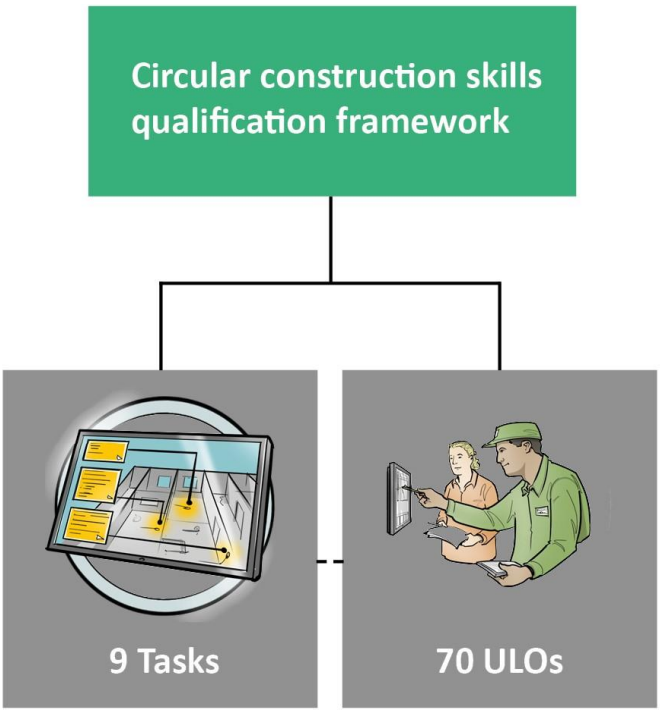


Figure 3. Overview of the main elements of the circular construction skills qualification framework.

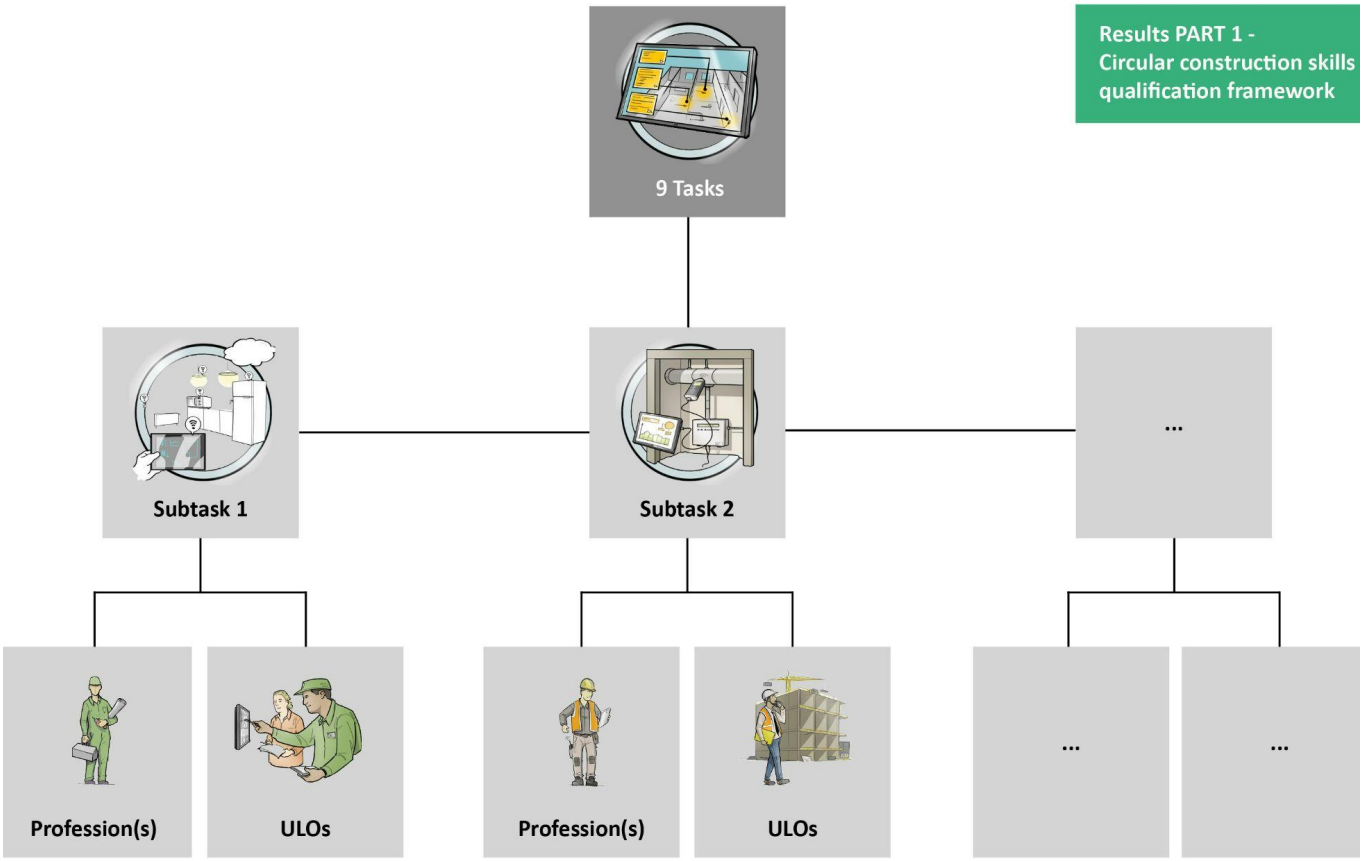


Figure 4. Overview of the results of circular construction skills qualification framework - Part 1, 9 tasks.

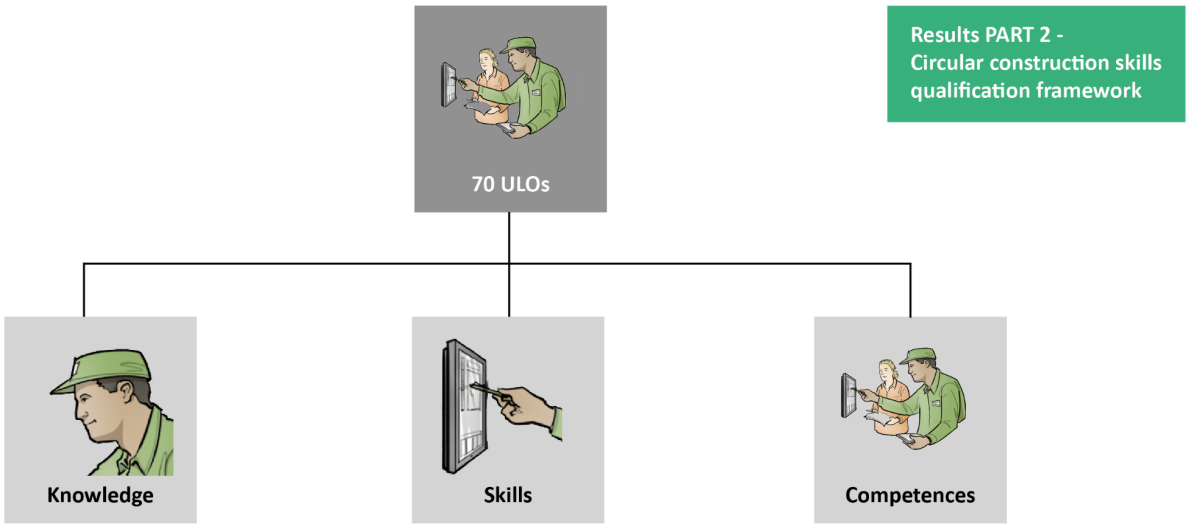


Figure 5. Overview of the results of circular construction skills qualification framework - Part 2, ULOs.

Table 1: List of Tasks and subtasks, including corresponding ULO numbers and professions

#	Task	Subtask	ULO Nr.	Profession(s)
1	Prioritise regenerative and efficient use of resources		81	
1.1		Design with bio-based, non-toxic and/or non-critical materials	1, 2, 3, 4	AM, UP, AR, CE, ME, EE, C, MS
1.2		Replace energy sources with less impactful alternatives	8	AR, EL, EE, PM, MS
1.3		Apply suitable energy efficiency measures to the building design (taking into account building purpose and climate)	9	AR, EL, EE
1.4		Generate energy from renewable sources - e.g. solar, sustainable biomass	10	AR, EL, EE
1.5		Apply measures that replace freshwater with less impactful alternatives	6	R, Gd, P, El
1.6		Enact water efficiency measures	7, 15	R, Gd, P, El
1.7		Source bio-based, reusable, non-toxic and non-critical materials	1, 2, 3, 4, 5, 36	PM, MS
1.8		Source local and lightweight materials	74	PM, MS
2	Design for the future		81	
2.1		Design to reduce waste during production and use	2, 26, 27, 28	AR, CE, ME, EL
2.2		Design with materials that enable multiple uses	5	AR, CE, EL, ME, HS, BS
2.3		Design buildings and installations that are made to last and to ensure longer use	31	AR, CE, EL, ME
2.4		Design products and building structures to enable reuse and recycling	29	AR, CE, EL, ME, HS, BS
2.5		Design products and building structures that make repair accessible	30	AR, CE, EL, ME, HS, BS
2.6		Design with use of pre-fabricated solutions	26	AR, CE, EL, ME
2.7		Design modular construction solutions	28	AR, CE, EL, ME, HS, BS
2.8		Design using secondary materials not initially intended for reuse	1, 14, 20, 23, 55, 78	AM, UP, AR, CE, ME, EE, C, MS
2.9		Design to use and store energy more efficiently in buildings	24	AR, EL, EE

2.10		Compile and provide deconstruction / demolition specifications at the commissioning stage	59	AR, CE, EL, ME, HS, BS
3	Assemble / construct for the future		15	
3.1		Install energy efficiency measures in buildings	56	II, WI, EI, RESI, RWT, HPI, VI
3.2		Install renewable energy systems in buildings	63	II, WI, EI, RESI, RWT, HPI, VI
3.3		Reduce waste during production and construction	58	Br, II, FM, FW, R, WI, BA
3.4		Build modular structures	60	Br, II, FM, FW, R, WI, BA, P
3.5		Build with bio-based, reusable, non-toxic and non-critical materials	68	C, CE, ME, SS, Br, II, FM, BA
4	Rethink the business model			
4.1		Construct building components according to service business models	15, 60, 62	C, CE, ME, BS, Br, II, FM, FW, R, WI, BA
4.2		Offer construction maintenance and repair services	43, 64	RM
4.3		Provide building and installation components as a service	42	PD, RM
4.4		Offer different leasing and rental models to provide access rather than ownership	44	PD, RM
4.5		Incentivise the renovation of un- or under-used buildings	45	C, BS, FaM, PA, AM
5	Stretch the lifetime		81	
5.1		Manage and preserve biological products on construction site	15, 17	C, CO, RM, FW
5.2		Maximise lifetime of products in-use	11, 12, 13, 57	AR, RM, DA, BO
5.3		Repair (active maintenance) existing structures and installations	15, 64	RM, EI, FM, FW, PHI, II, P, RESI, RM, RWT, VI, WI
5.4		Operate the building in a clever and adaptive manner that optimises sustainability and circularity	76, 77	FaM
5.5		Maximise lifetime of products after use	14, 16	DeA, DeL, RM
5.6		Adaptive reuse of existing buildings for a new purpose	66	DeA, DeL, AR, CE
6	Use secondary resources			

6.1		Reuse, repurpose or recycle secondary materials/components/resources from the same industry	18, 20	PM, PD
6.2		Reuse, repurpose or recycle secondary materials/components/resources from other industries	21, 23	PM, PD
6.3		Organise logistics and storage of secondary materials	46, 48, 73	C, PM, HS, DeA
6.4		Assess the quality of materials to be reused (audit of waste)	78	DeA, MS
6.5		Transform waste streams for reuse, repurpose, or recycle waste streams within the same industry (closed loop)	19	DeA, DeL, CE, SC, AR
6.6		Transform waste streams for reuse, repurpose, or recycle waste streams within other industries (open loop)	22	DeA, DeL
6.7		Organise and provide guarantees for reused materials	47, 73, 82	C, CE, ME, EE, FdE
6.8		Disassemble modular structures	15, 65	AR, DeA, DeL, HS
7	Incorporate digital technology			
7.1		Employ digital marketplaces to improve circular allocation of resources between stakeholders	48	DA
7.2		Employ material passports throughout each phase of the building/project	47	AR, CE, C, HS, DA, FM, BS
7.3		Employ technologies to gather and analyse data to provide and gain insights on resource use at each stage of the life cycle	46, 47	DA
7.4		Trade secondary materials and products on digital marketplaces	16, 48, 79	MS, PM, PD
7.5		Use drones and imaging technologies to collect data about the building and analyse the building for renovation	84	DA, HS
7.6		Apply Building Information Modelling (BIM) practices to building projects in order to aid circular applications	57	DA, AR, CE, C, HS, BS
8	Collaborate to create joint value			
8.1		Put in place purchasing guidelines for procurement departments	34	PA, PM, GPPA
8.2		Engage internally to guide employees and facilitate greater	32, 33	Senior management of company in

		knowledge sharing between internal divisions		construction value chain
8.3		Collaborate with industry peers to create joint value and identify synergies	34, 35	ME, CE, AR, PM, HS
8.4		Engage and guide customers and users to ensure circular use of buildings and products	37, 38	PD, PA, II, HPI, AR, BEC, RESI, RWT, VI, P, EI, FM, SC
8.5		Engage with local communities where buildings are located	12, 41	AR, PA, AM, PD
8.6		Engage with governments on circular economy policies and programmes	39, 40	AM, AR, FaM, PA, PM, PD, GPPA
8.7		Redefine building regulations to incentivise circular approaches in construction	80	PA
9	Strengthen and advance knowledge			
9.1		Educate construction clients on suitable construction and renovation options	53, 54	PA, BEC, FaM, BO, AM, AR
9.2		Engage and guide customers and users to ensure circular use of buildings and products	37, 38, 75	PA, BEC, FaM, BO, AM, AR
9.3		Raise awareness about secondary construction components and materials, and reconstructed buildings	53, 55	PA, BEC, FaM, BO, AM, AR
9.4		Integrate principles of circularity into school curricula	49	PA
9.5		Conduct workplace trainings on circular construction	49, 50	AR, CE, C, ME, EE, PM etc.
9.6		Solidify definitions and create frameworks to support understanding of circular construction	39, 51	PA, BEC, FaM, BO, AM, AR
9.7		Develop and conduct research about applied circular construction strategies	52, 82	AR, PA, EL, ME, CE, EE
9.8		Conduct post occupancy survey and analysis	77	BO, HS, FaM
9.9		Increase (access to) understanding of non-conventional construction materials	34, 47, 82, 83	AR, MS, ME, CE, EE, UP, AM, C
9.10		Evaluate and assess the life cycle impacts of buildings,	25	AR, EE, SC, BEC, CO, GPPA

		construction products and materials on the environment (emissions, soils, water, biodiversity, etc.)		
9.11		Conduct a feasibility study for the new built or renovation project at hand	61	AM, AR, C, PD

Table 2: Unit of Learning Outcomes, consisting of competences, skills, and knowledge components

ULO Nr.	Competence	Skills	Knowledge
1	Design with bio-based materials as an alternative for conventional construction materials	Select bio-based materials for the construction project at hand Consider the purpose of the building and the context of the entire building solution, as well as construction requirements When biobased materials are not an option, select low impact materials Integrate use of the Material Circularity Indicator (make sure it is not higher than X) Ensure use of materials that have little to no volatile organic compound (VOC) emissions	Types of bio-based materials in construction such as hemp, seaweed, cork, bamboo, sustainably sourced wood, agricultural residues Advantages and disadvantages of biobased materials Seven functional requirements of building walls Alternative forms of concrete
2	Enact measures that optimise material use to strive for material efficacy	Apply measures that optimise material use to construction projects Combat underutilisation or surplus of materials by sharing products or assets and optimising their use	General knowledge about measures that optimise material use in construction, such as 3D printing or accurate structural design/ industrialised prefabricated products
3	Design with non-critical raw materials as defined by the EU	Avoid, insofar as possible, use of critical raw materials as defined by the EU while selecting	Types of non-critical raw materials as defined by the EU

		materials for a project	
4	Design with non-toxic materials as defined by the EU	Avoid, insofar as possible, use of chemicals as defined by EU while selecting materials for a project	Types of non-toxic construction materials, such as alternatives to anti-flame retardants used on wood
5	Design with products and materials that can be easily reused or recycled after use	Recognise and select materials that can be easily reused or recycled after the building's end-of-lifetime Recognise and avoid composites or other mixed materials that are then hard to recycle/repurpose	Reusable and/or recyclable materials, such as glass, plasterboard, steel, gravel (aggregates), rammed earth walls Recycling requirements for specific products and materials for safety and functionality (and regional/local infrastructure capacity)
6	Replace freshwater use with alternative water sources	Use alternative water source applications that are suitable for the project at hand Harvest greywater and rainwater for certain applications Design sustainable drainage systems	Alternative water sources such as rainwater, fogwater, seawater, grey water etc. Which building applications are suitable for applying alternative water sources Sustainable drainage systems
7	Enact measures that optimise water use for water efficiency	Apply plant-based biofilters/ phytopurification Collect and reuse of water in humid interior areas (e.g. cellars) Create water cascading systems Harvest greywater and rainwater for certain applications	Sustainable water technology Plant-based biofilters to purify wastewater Criteria for reuse of water Cascading water for efficiency
8	Select sources with less impact to apply to operations in buildings	Select best energy solution that is less impactful based on current situation in country (e.g. convert fossil fuel based operations to electric)	Fossil fuel based operations vs. electric operations Renewable fuels, such as biomass How circular economy works with regards to materials and sources, renewability Current state of affairs and regulations with regards to energy sources

			Options like waste heat/district heating
9	Enact measures that reduce and optimise energy use	Include energy efficiency measures in design Include passive design techniques in design	Smart solutions to spread demand throughout the day Measures such as draught-proofing, airtightness, insulation, ventilation Materials with lower thermal conductivity (e.g. sheep's wool, cellulose, earthwool)
10	Generate energy or heat/cold from renewable sources in building design	Include renewable energy technologies in building design	Options for renewable energy, e.g. solar/PV panels, solar thermal collectors, heat pumps, waste water heat recovery Systems that generate power or heat/cold
11	Provide repair services or maintenance services for building components	Renovate buildings or parts of buildings to maximise their lifetime Conduct regular checks for built structures	Renovation techniques Renovation of bio-based, non-critical and non-toxic materials
12	Provide upgrade programmes or upgrade services for building components	Educate home-owners and facility managers on the possibilities of upgrading building components Provide upgrade services	Which (local) organisation can help upgrade building components Upgradeability of the building components at hand
13	Provide DIY repair kits or spare part programmes for enabling self-repair	Describe information about how to repair and maintain building components to building users and facility managers	DIY techniques for repair and maintenance
14	Extract and reuse parts from end-of-life products for use in new buildings	Dismantle built structures whilst maintaining value of products and materials Read construction details for detachability of building components	Dismantling for re-use Detachable construction details
15	Arrange a safe working environment and continuously consider health and safety requirements	Arrange a safe working environment at the construction site Consider health and safety requirements	Health and safety requirements specific to biobased and secondary materials (construction) Requirements specific to renewable energy

		Assure sufficient environmental air quality	technologies and smart solutions (installation) Hazards of certain materials and their compositions
16	Enable second hand sale of products through marketplaces or services	Make use of (digital) marketplaces to find a new use for disassembled materials (construction) Make use of (digital) marketplaces to find a new use for disassembled products and parts of products (installation)	Potential new purposes for construction materials and products
17	Manage and preserve biological products on the construction site to stretch the lifetime materials	Preserve and manage biological products	Preservation and management of biological products on site Periodic treatment and maintenance of wood, straw and other bio-based materials used for the building.
18	Collect products and materials for reuse or recycling from the construction industry	Source demolition materials for construction of new structures Select waste products and materials for construction of new structures Prioritise local demolition materials to save resources Use digital marketplaces to collect products and materials	Usable and suitable waste products and materials Allocation of local demolition materials Collection programmes that process materials for reuse or recycling within the construction sector Closed loop waste streams
19	Transform waste products and materials for reuse or, as a last resort into lower value products, in the same industry	Transform demolition materials into products that can be used in new built projects Conduct activities to clean and restore products back to working condition for original or new purposes	Upcycling methods Closed loop waste streams Cleaning, documentation, refurbishment or any physical/chemical treatment to allow reuse Strategies to clean and restore products and materials
20	Use waste products and materials from	Reuse demolition materials as a resource for new	Different functions for waste materials in new

	construction demolition projects that have been processed and recycled	buildings	building Closed loop waste streams
21	Collect products and materials for reuse or recycling from outside construction	Source demolition materials for construction of new structures Select waste products and materials for construction of new structures Use digital marketplaces to collect products and materials	Usable and suitable waste products and materials Collection programmes that process materials for reuse or recycling outside the construction sector Open loop waste streams
22	Transform waste products and materials for reuse outside construction or, as a last resort into lower value products, outside construction	Use demolition materials as resources for other purposes or products outside construction Separate waste created during construction Conduct activities to clean and restore products back to working condition for original or new purposes	Open loop waste streams Strategies to clean and restore products and materials
23	Use waste products and materials from outside construction that have been processed and recycled	Reuse materials as a resource in new built projects	Open loop waste streams For example recycling PVC cables into floors
24	Enact measures to use and store energy more efficiently in buildings	Employ batteries for storing renewable electricity produced Utilise a thermal tank to store excess hot water stored on site Make use of phase change materials to store excess heat or cold.	Storage of heat and cold, storage of excess power
25	Evaluate and assess life cycle impacts of buildings, construction products and materials on the environment (emissions, soils, water, biodiversity, etc.)	Apply a lifecycle assessment tool to evaluate the embodied energy and carbon footprint of a new building or the renovation upgrade of an existing building	e.g. One ClickLCA tool Awareness of new circular economy legislation as is currently passing through Irish parliament
26	Design buildings and building components	Design prefabricated solutions	Prefabrication (incl. relevant software)

	for prefabrication so that as little waste as possible is produced during construction	If applicable, 3D print building components Use CNC and/or robotics for prefabrication	Alternative prefabrication methods such as 3D printing (incl. digital rendering) Sustainable insulation materials in prefabricated walls
27	Design products so they use as little materials, water, energy, etc. as possible during use phase	Reduce the consumption of total raw materials needed for construction Consider resource efficiency for design of all life cycle stages (e.g. minimum energy consumption during use phase)	How to minimise raw material use for construction project
28	Design modular structures so that buildings can be disassembled and reused after end of service life	Design modular structures Write and interpret detachable construction details Prioritise standardised solutions and systems to increase possibilities of reuse	Why custom made structures should be avoided (more difficult to reuse after disassembly) Detachable construction details
29	Design products and building structures to enable reuse and recycling	Design building components that consist of multiple parts that can be easily disassembled Enable easy recyclability for the designed building component Design with reuse for the same or different purposes in mind 'Legolise' the construction of buildings	Material passports Modularity to enable easy disassembly
30	Design products and building structures that make repair accessible	Design building components so that they are easy to repair by home owners or facility managers	Modularity to enable exchange of (parts of) products or materials Design strategies to allow for easy repair Material passports
31	Design products and building structures that can serve a long and useful life, as well as stay relevant to residents and	Select materials and technologies that resist damage and wear Design for flexible use to adapt to changing needs	Design strategies for flexible use of buildings Materials that ensure longevity of buildings

	users	of occupants (e.g. partition walls and systems)	
32	Facilitate discussions and meetings between internal team members to identify circular opportunities	Apply circular strategies within the firm to serve as an example Provide internal training about circularity topics (e.g. about circular procurement) Facilitate open discussions about circularity	Circular strategies Training strategies (Group) conversation strategies for circularity
33	Integrate circular economy thinking into employee evaluations that are linked to professional compensation	Integrate circular economy thinking into employee evaluations Link circular employee skills to professional compensation	Circular economy thinking for employee evaluations
34	Put in place purchasing guidelines for procurement departments	Evaluate material suppliers on circular economy principles and guidelines Setting up purchasing guidelines for procurement Improve procurement further by acting regionally Include other lifecycle phases, such as renovation or dismantling works	Circular procurement/GPP Energy Performance Contracting and other performance-based servitisation models
35	Collaborate with industry stakeholders to share best practices and act together	Engage in discussions with industry stakeholders to share circular economy best practices Push stakeholders towards greater circularity Identify potential synergies Engage in activities or projects that advance circularity together Establish regional construction networks	Strategies for promoting greater circularity
36	Make choice of materials between different tender options	Require Environmental Product Declarations (EPDs) Interpret EPDs	Tender options like bio-based (timber) versus secondary (recycled concrete or steel)
37	Work together with residents and users to jointly create products and buildings fit for	Organise feedback from consumers in order to improve the product in next applications	Co-creation strategies

	them		
38	Engage in discussions with construction customers to raise awareness of the circular economy and explore circular opportunities together	Educate residents on sustainable construction and renovation options Provide consumers with reliable data on the environmental footprint of their choices Provide programmes for home owners and users to help people become more circular	Ecolabelling Renovation options for different types of building structures
39	Engage in discussions with government bodies and policy makers to push for regulations that support circularity	Establish circular construction and demolition criteria Open and engage in discussions with government bodies and policy makers	Public private partnerships Which government bodies and policy makers are relevant to interact with
40	Participate in government programmes that support and advance the circular economy	Select relevant government programmes Contribute to government programmes for circularity	Government programmes that support and advance circular economy
41	Work together with the (local) community and engaging them in the company operations	Develop high-value, circular product applications through community collaboration	Strategies to engage people in local communities with company projects Benefit of creating new job opportunities by applying circular strategies in the value chain
42	Provide building components (e.g. installations, electrical products, partition walls) as a service instead of as a product	Set up a product business model for building components Provide building components as a service Provide services through a subscription plan with regular payment schemes	Strategies for providing building components as a service (e.g. installation company ensures good indoor climate and remains owner of installations) Subscription plans
43	Offer construction maintenance and repair services with help of service business models	Provide maintenance and repair services to buildings as a service Emphasise a locally skilled workforce to provide services	Service business models
44	Offer different leasing and rental models	Provide leasing or rental models for buildings and	Leasing models

	to provide access rather than ownership	installations Recognise and prevent under-use of existing built space Organise multi-use or sharing of spaces (e.g. office buildings used by civil society organisations in evening or weekends)	Rental models Options for multi-use, sharing of spaces, e.g. co-housing
45	Incentivise the renovation of currently unused buildings	Provide reasonable incentives to firms or individuals who choose to renovate an unused building Set up projects for incentivisation	What incentives are suitable Models for incentivisation
46	Apply digital tracking of materials to optimise maintenance, demolition, and recovery of buildings and components	Apply digital tracking of materials used in the construction project Provide and gain insights into the materials used	Digital material tracking software Methods to track materials Use of BIM On site tracking ID's / RFID
47	Develop and apply material and building passports	Develop and apply material and building passports Ensure availability of material and building passports to everyone	Material passports Buildings passports Use of BIM
48	Employ a regional construction digital marketplace for construction resources	Set up a regional construction digital marketplace Utilise existing online platforms to enable digital marketplace Persuade and incentivise use of digital construction marketplace by stakeholders	Digital marketplaces Methods for setting up a digital marketplace Peer-to-peer exchange of materials and products Use of BIM
49	Incorporate circular strategies, archetypal circular interventions and case studies into educational programmes (in the construction value chain)	Incorporate circular strategies into educational programmes Incorporate archetypal circular interventions into educational programmes Incorporate case studies into educational programmes	Suitable approaches for primary, secondary and tertiary education curricula Suitable approaches for lifelong learning and workplace training Distinguish between types of professions in training

50	Provide training about circular procurement within the built environment	Set up circular procurement training Provide circular procurement workplace training Provide guidance to trainees Set up a training agreement	Circular procurement strategies and methods How to engage trainees with regards to procurement
51	Solidify definitions of circular construction by being consistent and using circularity frameworks	Explain what circularity means in construction	Key Elements of the circular economy Circularity definitions and which to maintain
52	Conduct research about applied circular construction strategies	Generate knowledge on applied circular strategies in construction by case studies and meta studies Analyse effectivity, barriers and successes of applied circular strategies in the construction sector Give informed advice for future applied strategies	Case studies and meta studies Suitable applied strategies for research
53	Follow developments in the field of environmental costing models and CO2 taxes	Distinguish and interpret environmental costing models and CO2 taxes by following the right sources to remain familiar	Environmental costing models CO2 taxes
54	Educate property/home owners on sustainable construction and renovation options	Explain potential sustainable construction and renovation options Motivate industry and construction clients about renovation options.	Strategies for educating property/homeowners
55	Raise awareness about recycled construction materials and reconstructed buildings	Raise the awareness of stakeholders about reconstruction of buildings and recycled construction materials Explain the value of reconstruction of buildings and recycled construction materials Motivate stakeholders and break unwillingness to use new construction materials or build new	Recycled construction materials Reconstruction of buildings
56	Install energy efficiency measures	Apply smart solutions to installations	Energy efficiency solutions, e.g. ventilated roofs,

		Conduct draught-proofing in buildings Conduct airtightness testing Apply suitable method for creating airtightness Build with passive design techniques	air quality, insulation, airtightness. Draught-proofing for efficient use of thermal energy Passive design techniques (e.g. passive solar heating, solar collectors like atriums, crossed ventilation, inertia)
57	Employ BIM to get insight into the effects and changes affiliated with upkeep, repair, or improvement of buildings	Make use of BIM for upkeep and repair purposes	BIM for repair information
58	Reduce waste as much as possible during production of buildings and components	Reduce waste as much as possible during construction Prepare detailed planning of materials Order just in time Avoid overlong on site storage of materials Incentivize building crew to avoid waste (=don't reward haste) Collect multiple separated waste streams on site	Strategies to reduce waste
59	Compile demolition specifications and provide them at final commissioning of the building	Compile clear demolition specifications of the building	Demolition specifications / detachable construction details
60	Assemble modular structures	Modular construction systems and their procedures for assembly Apply removable joints Apply sealants that allow for disassembly (e.g. not glueing them or using PUR or KIT for mounting)	Modular construction systems and their procedures for assembly (incl. prefabricated modules) Removable joints (incl. those made from non-conventional materials, whilst maintaining

		Ensure that connections made are accessible	quality of joints) Wall panels, dowels, slot systems etc.
61	Conduct a feasibility study to, if applicable, prioritise renovation, minimise used surface, and minimise the total mass of materials to be used	Conduct a feasibility study to explore possibilities of renovation in order to avoid building new when buildings can be reused Conduct a feasibility study to scan possibilities to minimise the amount of surface used for new built/renovation project Conduct a feasibility study to scan possibilities to minimise total mass of materials used in the project Ensure that results of feasibility study comply with statutory requirements	Feasibility studies in construction projects Statutory requirements for feasibility study
62	Construct building components according to service business model	Assemble building components properly Ensure that building components are properly assembled as components (e.g. not glueing them or using PUR or KIT for mounting) Needs to be specified with more details of craftsmanship on site in order to assemble building components properly	Buildings as a service not as a property Modular construction systems and prefabricated modules
63	Install renewable energy technologies in buildings to generate power or heat/cold	Install solar PV panels Install heat pumps	Renewable energy technologies, such as solar panels, heat pumps, waste water heat recovery
64	Maintain and repair built structures and installations in order to maximise lifetime	Maintain and repair built structures and installations (incl. renewable energy technologies) Renovate buildings or parts of buildings to maximise their lifetime	Repair techniques for buildings and installations Renovation techniques Renovation of bio-based, non-critical and non-toxic materials
65	Disassemble modular structures for reuse	Disassemble modular construction systems Write and interpret detachable construction	Modular construction systems Detachable construction details

		details	
66	Rebuild existing buildings for a new purpose	Rebuild disassembled buildings Adaptive reuse of existing buildings for a new purpose	Modular construction systems
68	Apply bio-based, non-critical, non-toxic, and/or reusable products on site whilst maintaining material efficacy	Apply bio-based, reusable, non-critical and/or non-toxic materials at the construction site Enact measures that optimise material use to strive for material efficacy Collect leftover materials	Applications and characteristics of different bio-based materials, what to keep into account while applying them Alternative forms of concrete Applications of reusable and/or recyclable materials General knowledge about measures that optimise material use in construction, such as 3D printing
73	Organise logistics and storage of secondary materials	Collaborate with resource hub(s) Include data and knowledge about materials in passports Prioritise local storage and distribution	Resource hubs/ material banks
74	Source local and lightweight materials if possible	Source local and lightweight materials	How to work with resource hubs or materials banks
75	Provide documentation as guideline to use the building properly in order to stretch its lifetime	Provide information about how and when to maintain the building Create guide for building users	When and how built structure at hand needs regular checks and repair Any kind of documentation as guideline for users
76	Operate the building in a clever manner that suits the current situation best, looking further than solely the original design to optimise sustainability and circularity	Operate the building while considering post-occupancy evaluation, changes in use, and the search for energy and material savings during operation Adapt building operation to changes in use and context	Post-occupancy evaluation (incl. evaluation during use phase of building) Options for energy and material savings during operation

77	Conduct post occupancy survey and analysis	Conduct post occupancy survey and analysis	The importance of post occupancy survey and analysis (also during operation) The purpose of this is to provide feedback to design practices of design professions
78	Assess quality of materials to be reused (audit of waste)	Conduct effective end-of-life assessment about used materials Make decision about reuse of materials Share feedback about quality to constructor and architect Distinguish between high-quality and low-quality reuse	If applicable, connect end-of-life assessment to purpose of the building that the materials are to be used for
79	Trade secondary materials and products on digital marketplaces	Employ (regional) digital marketplace to trade used construction materials that have been selected for reuse	How to use digital marketplaces to sell (transformed) used materials
80	Redefine building regulations to incentivise circular approaches in construction	Redefine building regulations to incentivise circular approaches in construction	What the existing building regulations are and how they interact with circular approaches
81	Comply with applicable (national/local/EU) legal requirements	Comply with applicable legal requirements	What are the relevant legal requirements (e.g. CPR, functional requirements of building walls) National and regional legal requirements
82	Organise and provide insurance and guarantees for reused materials to buyers	Organise insurance and guarantees for reused materials Provide insurance and guarantees for reused materials	Material passports
83	Increase (access to) understanding of biobased construction materials	Conduct research about quality and characteristics of biobased materials Feedback material research results to established construction requirements	Construction requirements

		Experiment with materials to innovate and discover new sustainable methods of construction	
84	Use drones and imaging technologies to collect data about building and analyse building for renovation	Use drones and imaging technologies to collect data about building and analyse building for renovation	Drones and imaging technologies for collecting data in construction projects

3. Approach

For development of the task-based qualification framework, a methodology developed within the NEWCOM project, which was later fine-tuned in several other European H2020 projects, has been used. This paragraph will explain the origin, validation, and added value of the methodology, as well as how it works. Additionally, resources used as input for the qualifications are clarified below.

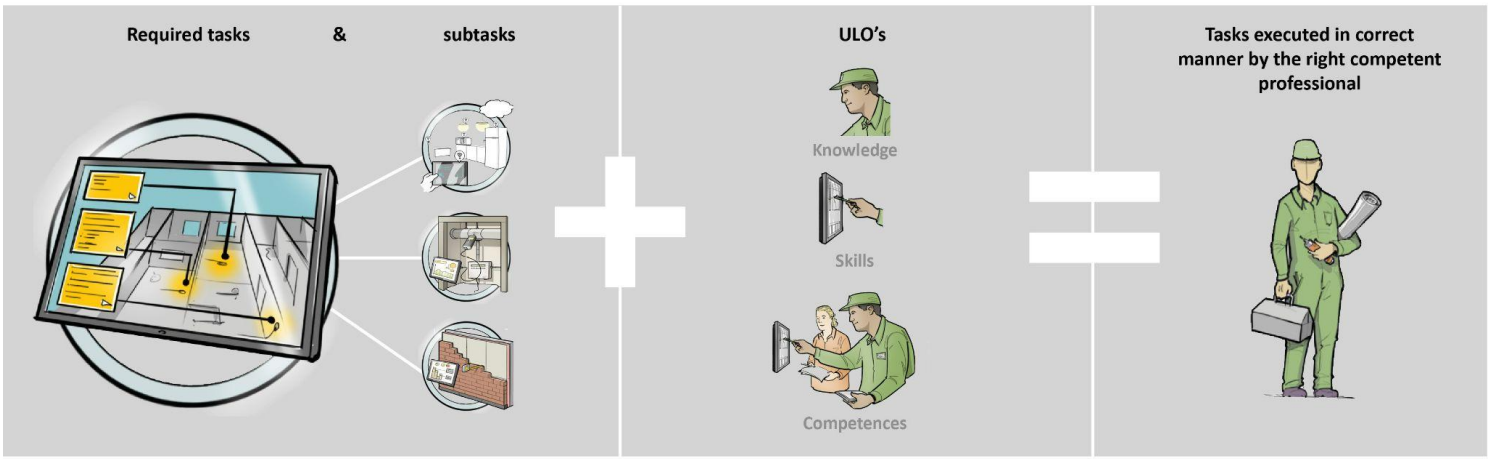


Figure 6. Overview of the methodology

3.1. Task-based qualifications

The methodology for compiling task-based qualifications used in BUS-GoCircular was first established in the so-called NEWCOM project. NEWCOM is a European-wide project in which training schemes for construction workers and professionals are developed, as well as a basis for the recognition of these schemes (e.g. by means of a competence database).[6]

The purpose of the methodology is, on the one hand, to decide what specific tasks and subtasks a professional should tend to (hence 'task-based'). On the other hand, each subtask is linked to a unique Unit of Learning Outcome (ULO). ULO's consist of a competence, skills, and knowledge element. Altogether, information needs to be added about which professionals are needed for each subtask. In connecting subtasks to

[6] Newcom: Newcomtraining. Österreichische Energieagentur. https://www.newcomtraining.com/newcom

corresponding professions, one can decide which learning goals members of a profession should possess and thus what learning outcomes need to be acquired.

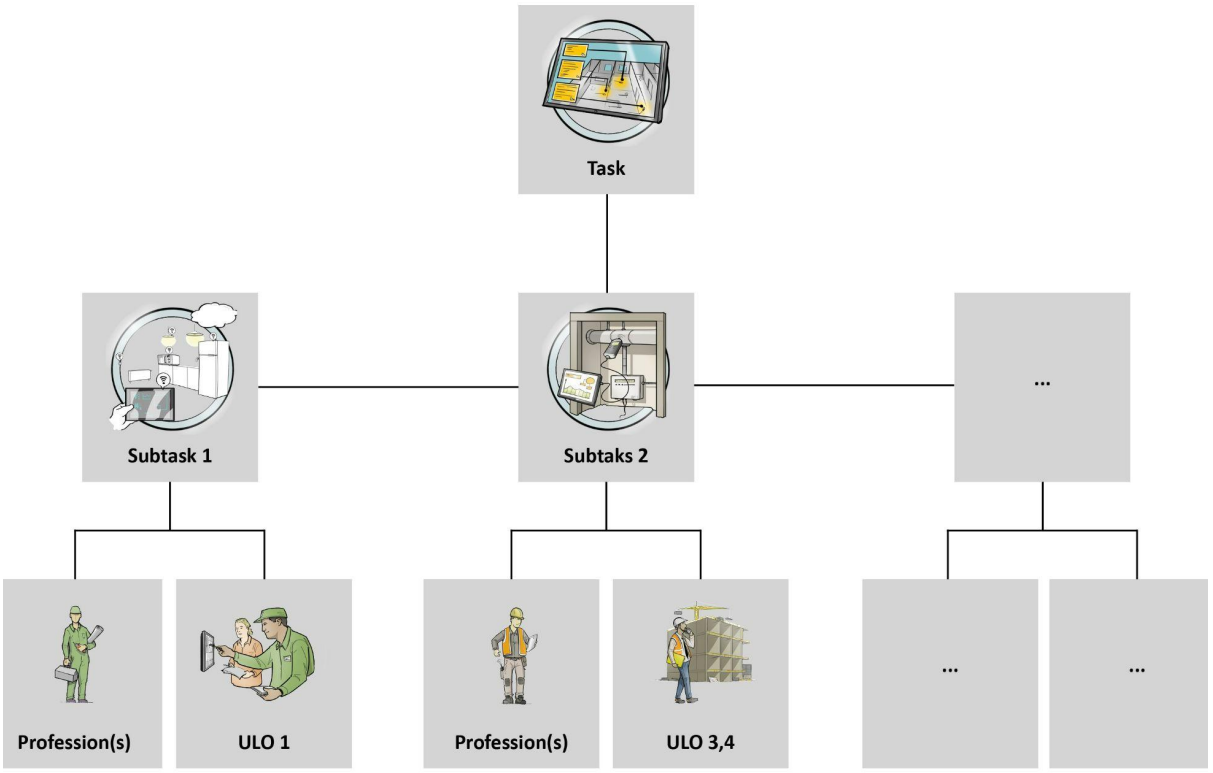


Figure 7. Relationship tasks, subtasks, ULOs and professions

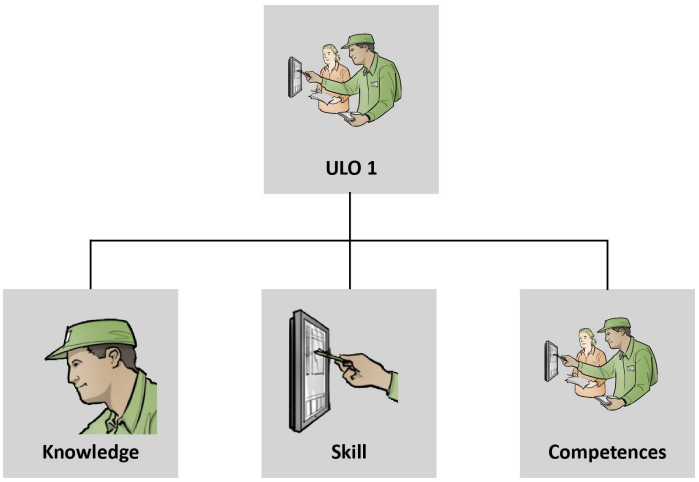


Figure 8. Elements of ULOs

All ULOs are to be stored in a database of the BUILD UP Skills advisor-app, where they can then easily be labelled with locations of existing learning content, for example training and

upskilling initiatives. If a certain competence is applied to multiple (sub)tasks, the ULO has to be written only once.

The outcomes of a set of task-based qualifications enables decisions about what exact profile professionals should possess. It can help with standardising certification, developing new training materials, and connecting to micro-learning and micro-credentials.

In BUS-GoCircular, the task-based qualification framework for circular construction skills will be used in two ways: a) to expand the repository of the BUS Advisor app with the Unit of Learning Outcomes and associated learning content in the Catalogue, and b) to work on future tasks within the BUS-GoCircular project, by using the qualifications as inputs for developing Train-the-Trainer and mentoring programmes.

3.1.1. Previous applications

The methodology for compiling task-based qualifications has been finetuned and validated throughout the course of several large-scale European wide projects, apart from the previously mentioned NEWCOM project. Some examples are listed below.

- Before NEWCOM, in projects PROF/TRAC and BUStoB, work was done on qualifications for (interdisciplinary) skills for professionals and craftsmen in the construction and installation sectors. However, the qualifications developed here were not yet task-based.
- Building on the qualifications mentioned from the PROF/TRAC and BUStoB projects, NEWCOM took the qualification methodology, and made major improvements to it. From now on, learning outcomes were based on tasks and subtasks.
- In other projects, task-based qualifications were implemented. BIMplement, TripleA-reno, and BUSLeague. This ensured further validation of the methodology.
- Besides applications in EU projects, the method is applied in consultancy projects based in the Netherlands. There, the composition of task-based learning outcomes takes place for training purposes. Examples of project topics from the past are heatpumps, PV panel installation, infrared heating installation, heat network installation, fusebox aggravation, and installing charging stations for electric vehicles.

- In the future, the task-based qualifications method will, besides BUS-GoCircular, also be applied in the ARISE and SEEtheSkills projects.

3.1.2. Added value

The result of applying the methodology for compiling task-based qualifications is a set of hands-on, usable learning outcomes that correspond to relevant professions. The method is useful for reaching recognition of skills across countries. Task-based descriptions help steer users' focus towards the actual competences of professionals.

Additionally, the opportunity for recognition of skills provided by task-based qualifications can be connected to micro-learning and micro-credentials. Development of micro-credentials can be further facilitated, and transparency in terms of what they represent can be enhanced.[7]

In the past, the task-based approach has proven to be feasible to harmonise the qualification at EU level with adjustments for national specific elements, in order to enable mutual recognition.

3.2. Knowledge input for the Circular Construction Skills Qualification Framework

In this paragraph, the developed content of the circular construction skills qualification framework will be explained. In general, a focus on applying principles has been dictated. When applying circularity in construction, professionals will rarely have to learn new skills starting from the very beginning; they will need to make adjustments to their current way of working, and this is what mainly needs to be considered in the qualification framework.

The main foundation of the qualification framework was the BUS-GoCircular Framework for Circular Interventions. More information about this can be found in paragraph 2.2.1. According to the project task description (T2.3), the qualification framework should consist at least consider:

- Circular economy strategies (from the 8 Key Elements)
- Circular principles (such as sustainable materials, modular systems, business models, etc.)

[7] Cromwijk et al., 2022

- Circularity applied to Energy Efficiency (EE) and Renewable Energy Resources (RES)
- Digital skills needed for implementing circularity, including required BIM maturity levels
- All phases in the construction process and all actors involved in the value chain.

As to the obligatory inclusion of digital skills, a subtask and corresponding ULO for working with BIM has been included. BIM-maturity and its applications for circularity will be further elaborated in H2020 sister project *ARISE.*

3.2.1. Framework for circular interventions

In BUS-GoCircular Task 2.1, the consortium has created a Framework for circular interventions in the construction value chain. As mentioned, this was the main foundation of the current deliverable.

The Framework for circular interventions was based on the existing Key Elements of the Circular Economy framework.[8] The Key Elements were developed to define a common language for the circular economy. There are 8 elements that consist of; core elements, which deal with physical flows directly, and enabling elements, which deal with creating the conditions or removing barriers for a circular transition. For each element, 25 strategy groups in total are identified. For example, the first key element (*prioritise regenerative resources)* is connected to three strategy groups: regenerative materials, regenerative water, and regenerative energy. These 25 strategy groups in turn form the basis of how circular strategies for the construction sector specifically have been identified in Task 2.1.

The circular construction interventions identified for each strategy group were then connected to relevant professions for each stage of the construction value chain. It then becomes clear what job roles are involved in carrying out the work activity needed to implement the circular strategies. See Figure 1 for a fragment of the framework.

[8] Circle Economy. Key Elements of the Circular Economy. Key elements of the circular economy - Knowledge Hub | Circle Lab (circle-lab.com)

Core key element	Strategy group	Approach to circular construction	Plan*	Procure	Construct	Operate	EoSL
Prioritise regenerative resources	Regenerative materials	- Build with sustainably sourced wood - Build with hemp, seaweed, cork, bamboo, earth, etc. - Use alternative (bio)forms of concrete - Reduce size of building envelope and floor space e.g. through shared and multifunctional building spaces - Use of reusable or recyclable materials, e.g. glass, plasterboard - Use prefab to avoid material losses on site - Use non-toxic construction materials, e.g. alternatives to anti-flame retardants used on wood - Avoid the use of CRMs for construction e.g. natural rubber - Lightweight design and 3D printed building materials - Build with sustainably-sourced agricultural residues, e.g. straw / sheep's wool as insulation	AR MS ME CE EE UP AM C	MS PM	C CE ME SS Br II FM BA	FaM C CE ME SS Br II FM FW R WI BA	DeA DeL

Figure 9: Circular interventions identified for the first strategy group of the first key element. *Note:* Here, you can see how professions were related to the 5 stages of the built environment.

The Framework for circular interventions has been used to compile the qualification framework in order to make maximum use of existing strategies and current successful interventions in the field. It is used to understand what practical actions exist in circular construction and then convert it to the tasks and subtasks one needs to carry out to implement circular strategies. Subsequently, it became straightforward to link subtasks to professionals who will be executing them in practice.

3.2.2. Additional resources

Alongside the use of the BUS-GoCircular Framework for circular interventions as a foundation for the qualification framework, several other resources have guided the development of the task-based qualifications. This paragraph will focus shortly on the inputs from sister project BUSLeague, and the BREEAM-NL sustainability assessment method

BUSLeague

In H2020 project BUSLeague, a set of qualifications for cross-craft Energy Efficiency (EE)-skills has been compiled. This compendium has informed the writing of EE- and RES-relevant learning outcomes in the qualification framework.

BREEAM-NL

BREEAM is a sustainability assessment tool. Indicators for circular buildings have been proposed in a report from 2018[9]. A list of indicators has been used as a check for completeness of the qualifications. This check has indicated the addition of learning outcomes with regards to conducting feasibility studies, making use of the Material Circularity Indicator tool, considering VOC emissions, and providing demolition specifications.

4. Process

Insight into the process of the current BUS-GoCircular task provides transparency about the qualification framework. During the process, prominence was given to consortium collaboration and the involvement of expertise.

4.1.1. Collaboration and use of expertise

The first steps of developing the circular construction skills qualification framework were made independently by the task leader. During the second consortium meeting of the project, the first draft was then presented to the consortium, as to which some feedback was provided by partners.

After CM2, weekly meetings were organised, to which half of the partners attended each session. Thus, there was a 'Tuesday team' and a 'Thursday team', to make sure each partner can share their expertise to include relevant items in the framework. These meetings took place for four weeks, after which a final draft of the qualification framework was finalised. Collaboration was seen as a necessary part of the process, since feedback from people with different perspectives and backgrounds can help in developing a high quality qualification framework.

[9] Circle Economy et al. A Framework for Circular Buildings: Indicators for Possible Inclusion in BREEAM. 2018. https://www.metabolic.nl/publications/a-framework-for-circular-buildings-breeam/

An essential element of the task-based qualification methodology is expert consultation. This will take place during the next step of the project; by inviting focus groups with experts as part of the market validation in Task 2.4.

Additionally, as part of the process, BUS-GoCircular Task 2.2 (skills mapping) has been used as a test to ensure all relevant components were included.

4.1.2. Decision-making

During the development process, the decision has been made to classify main tasks as the 8 key elements. Minor alterations have been made to key elements. Namely, *prioritise regenerative resources* is named *prioritise regenerative and efficient use of resources.* Furthermore, considering the stages of the built environment value chain has prompted the inclusion of a new main task: *Assemble/construct for the future*. The construct phase made the partners realise that, for example, it is not enough to merely *design* modular construction solutions; they also need to be *constructed.*

From consortium partners' experience in the field, some additions were made to the subtasks, for instance: organise logistics and storage of secondary materials; assess quality of materials to be reused and; increase (access to) understanding of non-conventional construction materials.

Few information was deleted in the qualifications, as seen from the starting point of the Framework for circular interventions. However, the subtask *ensure energy recovery from waste* was deleted, because this was deemed a last resort option that should not be encouraged. Within the same line of thinking, in ULOs 19 and 22, information has been added that transforming waste products/materials into lower value products should be regarded as a last resort option; it is preferable to retain the value of materials. Moreover, it is of even greater relevance to a circular economy to keep materials in use for as long as possible through practices that extend building lifetimes, like durable design, repair, and renovation. The importance of these practices should come to the fore in the finaled framework.

5. Future developments and applications

The qualification framework is to be applied to the specified BUS-GoCircular focus of multifunctional green roofs, façades, and interior elements. Then, it is to be approved by the consortium and validated by stakeholders at national level (in Task 2.4). In the meantime, focus groups for market validation may provide input for necessary alterations.

After approval, the BUS-GoCircular consortium will use the qualification framework, together with the framework for circular interventions (Task 2.1), and the skills mapping results (Task 2.2), for further tasks in the project. Train-the-Trainer and mentoring programmes will be developed, as well as fundamentals training packs. Lastly, learning outcomes from the qualification framework will be added to the BUILD UP Skills Advisor app, in order to increase the recognition of circular skills in construction, and to direct professionals and workers to learning and upskilling that is right for them.

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7. Appendix I - Professions acronyms

Ambition setting and governance	Policymaker / Policy advisor	**PA**
	Green Public Procurement (GPP) advisor	**GPPA**
Asset management	Asset manager Real estate investor	**AM**
Urban planning	Urban planner	**UP**
Architecture	Architect Interior architect Architectural technician Designer	**AR**
	Landscape architect Green roof / green façade designer	**LA**
Civil engineering	Civil engineer Construction engineer Structural engineer	**CE**
	Façade design engineer	**FDE**
Electrical engineering	Electrical engineer ICT engineer Building automation engineer	**EL**
Mechanical engineering	Mechanical engineer Energy engineer	**ME**
Environmental engineering	Environmental engineer	**EE**
Building management	Facility manager	**FaM**
	Building operator	**BO**
	Data analyst BIM programmers, BIM designer Software engineer 3D image technician / engineer	**DA**
	Cost engineer Project manager and coordinator Quality control and assurance Quantity surveyor	**C**
	Health and safety (H&S) advisor H&S inspector Site supervisor	**HS**

Surveying	Site surveyor Land surveyor	**SS**
	Building surveyor	**BS**
Financing and procurement	Procurer / purchasing manager Procurement officer	**PM**
	Project developer	**PD**
	Material scout	**MS**
Energy performance	Building energy consultant Energy assessor	**BEC**
Sustainable building	Sustainability consultant Sustainability assessor	**SC**
Conservation	Conservation Officer Conservation scientist / ecologist	**CO**
Construction - building	Bricklayer Stone-layer, cutter and mason	**Br**
	Insulation Installers	**II**
	Carpenter Joiner	**FM**
	façade worker Plasterer	**FW**
	Roofers	**R**
	Gardener (roof and façade) Interior planter / landscaper Arboriculturalist / Horticulturist	**Gd**
	Window installer / glazer	**WI**
	Wood manufacturer and finisher Pre-fabricated building assembler Truss assembler	**BA**
Construction - Technical installations	Plumber	**P**
	Electrical installer and technician	**EI**
	Renewable energy systems installer (electric)	**RESI**
	Renewable energy systems installer (thermal)	**RWT**
	Heat pump installer	**HPI**
	Ventilation installer Air conditioning installer	**VI**
	Repair and maintenance operative Maintenance planner Safety maintenance operative	**RM**
Demolition and	Demolition / deconstruction labourer	**DeL**

deconstruction	Demolition / deconstruction supervisor	
	Site analyst Deconstruction auditor Urban miner	**DeA**

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Colophon