Co-funded by the Erasmus+ Programme of the European Union

BUILDING MATTERS
sustainability in the construction sector

BUILDING MATERS: Mitigating climate change transition risks of the construction sector through building capacity in sustainable building materials

Grant agreement no: 2022-1-RO01-KA220-VET-000087398

Transnational Toolkit for Training Package. Supporting the Deployment of the Sustainable Building Materials Knowledge

Contents

Executive summary 6

1. Content and Aim 7

2. Exploiting sustainable approaches for building materials 8

2.1 Content 8

2.2 Key areas of investigation in National context 9

2.2.1 Conventional building materials, their carbon, energy, and ecological footprint 9

Greece 9

Romania 10

Slovenia 10

Republic of North Macedonia 12

Germany 12

2.2.2 Sustainable building materials (with a focus on recycled and secondary raw materials); including technological developments and upcoming trends 17

Greece 17

Romania 17

Slovenia 18

Republic of North Macedonia 19

Germany 19

Italy 20

2.2.3 The status of the country's shift to sustainable materials and approaches, oriented legislation, in terms of harmonization with EU strategies and policies (e.g. EPBD, EED, building renovation passports, Energy Performance Certificates, Digital Building Logbooks, Smart Readiness Indicators), to achieve nearly zero energy buildings 21

Greece 21

Romania 23

Slovenia 23

Republic of North Macedonia 25

Germany 25

Italy 27

2.2.4 Implementation of EU tools/instruments for sustainable building (i.e., Level(s), ECO-Labelling, Green Public Procurement (GPP), BIM) 29

Greece 29

Romania 30

Slovenia 30

Republic of North Macedonia 31

Germany 32

Italy 33

2.2.5 Identification of institutional, technical, and organizational barriers and challenges for sustainable evolution and the use of sustainable materials in the construction industry 34

Greece 35

Romania 35

Slovenia 35

Republic of North Macedonia 36

Germany 36

Italy 37

2.2.6 Existing training provision/capacity-building programs in sustainable materials, and/ or relevant areas 38

Greece 38

Romania 42

Slovenia 43

Republic of North Macedonia 43

Germany 43

Italy 44

2.3 Transnational key findings 45

3. Liaising with the VET, the educational sector, the academia, the industry for identifying the utmost potential of sustainable building materials 45

3.1 Content/Aim 45

3.2 Participants profile in terms of type of organizations, services provided and main target group 46

3.3 Identification of institutional, technical, financial and organizational barriers, needs, challenges and opportunities for sustainable evolution and the use of sustainable building materials 47

Greece 47

Romania 47

Slovenia 48
Republic of North Macedonia 49
Germany 49
Italy 50
3.4 Familiarization with the National and EU strategies related to sustainable building materials, energy efficiency or relevant topics 51
Greece 51
Romania 51
Slovenia 51
Republic of North Macedonia 52
Germany 52
Italy 53
3.5 Main issues, needs and challenges in the use of sustainable building materials in relation to conventional ones 53
Greece 53
Romania 53
Slovenia 54
Republic of North Macedonia 54
Germany 54
Italy 55
3.6 Existing training provisions/capacity-building programs related to sustainable building materials (recycled / secondary raw materials) or relevant topics 56
Greece 56
Romania 56
Slovenia 56
Republic of North Macedonia 57
Germany 57
Italy 57
3.7 Current level of awareness and ways to raise awareness for the fight against climate change in general and with a focus on the construction industry 58
Greece 58
Romania 58
Slovenia 59
Republic of North Macedonia 60

Germany 60
Italy 60
3.7 Main challenges when designing a training curriculum for building professionals 61
Greece 61
Romania 61
Slovenia 62
Republic of North Macedonia 62
Germany 62
Italy 63
3.9 Main challenges when delivering a training curriculum for building professionals 63
Greece 63
Slovenia 64
Republic of North Macedonia 64
Germany 64
Italy 65
3.10 Key conclusions reached on transnational level 65
4. Transnational recommendations for the inventory of sustainable building materials 67
5. Transnational recommendations that should be linked with the training design 68
References 71

Executive summary

The Building Matters Project (**2022-1-RO01-KA220-VET-000087398**), supported by Erasmus+, aims to support awareness raising among key stakeholders on sustainable ways to mitigate climate change and transition risks in the construction sector. The project envisages the development of skills and competences in the green sector and sustainable building materials. This will be achieved through the introduction of forward-looking and innovative curricula and learning practices that are tailored to the needs of learners and enable sustainable behaviour change in line with the new European approach to construction.

The current Transnational Toolkit for Training Package was developed as a result of A2.3 Activity of the project (Delivery of the Sustainable Building Materials Awareness and Competence Transnational Toolkit). The aim of this result is to provide a comprehensive Sustainable Building Materials Awareness and Competence Transnational Toolkit that fosters a deep understanding of sustainable building materials and addresses the challenges associated with their implementation. The package aims to raise awareness and build competencies for sustainable decision-making in materials selection, empowering stakeholders in the construction industry to make environmentally responsible choices. This analysis serves as a dialogue and a profound investigation towards enabling sustainable decision-making in materials selection in building projects, as well as to enable VET representatives of the construction sector creatively exchange in accommodating sustainable curricula in their assets and increase their attractiveness to meet learners' and individuals' needs.

This handbook foresees a balanced combination of innovative learning activities and joint actions that allow the sharing of knowledge, expertise and the creation of networks at national and transnational level. The results of this toolkit will form the basis for the development of training programs and awareness campaigns foreseen in the next phases of the project. The basic philosophy of the handbook is to reflect in increasing awareness of environmental issues and the exchange of ecological practices. Finally, the handbook provides transnational key conclusions reached and recommendations for the inventory of sustainable building materials as well as for the training design of sustainable building materials curricula.

While there may be variations in the definitions and regulations across countries, common themes emerge. Sustainable building materials are characterized by their local sourcing, low embodied energy, non-toxic properties, and reuse potential. The use of industrial waste or by-products, such as supplementary materials, is highlighted as a way to make concrete sustainable. The need for data collection, database establishment, and policy implementation is also emphasized to drive sustainable practices and facilitate informed decision-making in the construction sector.

Within this ground, several technical/ institutional/ organisational barriers and challenges faced upon the use of sustainable building materials were highlighted by partner countries with the most significant to be:

- Lack of information, knowledge and education among builders, designers, clients and building owners about sustainable and durable building concepts
- Higher costs on sustainable building processes and materials related to conventional building materials that make sustainable construction more difficult
- The existing relevant European legal framework related to sustainability labelling, minimum sustainability requirements on public procurement of products, measures on raw materials and products has limited implementation
- Lack of coordination among authorities and organizations promoting durable and sustainable construction
- Liability concerns related to sustainable building materials including their limited testing, potential health and safety issues for occupants (operational health and safety issues) and failure to meet required standards and regulations
- Lack of legal provisions on public procurement, which could also stimulate green procurement. This is highly connected with the sustainable and circular economy concept

1. Content and Aim

The current handbook aims to provide a comprehensive Sustainable Building Materials Awareness and Competence Transnational Toolkit, which aims to enhance understanding and address challenges associated with the implementation of sustainable building materials at national and international levels.

The handbook includes a review of the existing legislative framework, current practices, level of awareness, issues, needs, and concerns related to sustainable building materials. Additionally, the handbook examines the training requirements and the need for sustainable decision-making in materials selection for the construction sector. It also discusses the experiences and results gained through previous and ongoing initiatives within the European Union (EU), with a focus on exploring progress, drivers, barriers, and outcomes in each participating country.

Lastly, the handbook offers key conclusions and recommendations for creating an inventory of sustainable building materials and developing training programs on sustainable building materials. These recommendations are based on research activities conducted by each partner country (Romania, Greece, Slovenia, Republic of North Macedonia, Germany, and Italy) in the following areas:

- Exploitation of sustainable approaches for building materials: investigating various sustainable approaches that can be adopted for building materials, considering factors such as environmental impact, resource efficiency, and life cycle analysis.

- Collaboration with VET, educational institutions, academia, and industry: engaging vocational education and training (VET) providers, educational institutions, academia, and industry

stakeholders to identify the maximum potential of sustainable building materials. This collaboration can help align education and industry needs, promote knowledge sharing, and foster innovation in the sector.

By addressing these research areas, the handbook aims to provide a coherent and comprehensive toolkit that enhances awareness and competence in sustainable building materials, while also promoting their adoption in construction projects.

2. Exploiting sustainable approaches for building materials

2.1 Content

In the context of this activity, the partners were asked to perform desk research review, study analysis, literature review for the current situation in the participating countries (Greece, Romania, Slovenia, Republic of North Macedonia, Germany, Italy) and offer deeper understanding in the following indicative areas of investigation:

- Conventional building materials, their carbon, energy and ecological footprint and environmental impact

- Key EU instruments stimulating sustainable use of building materials (e.g., Level(s), ECO-Labelling).

- Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) approaches and tools for sustainable decision making in building materials

- Technological developments, innovations and upcoming trends introducing sustainable building materials, with special attention to recycled/secondary raw materials.

- The status of the country's shift to sustainable materials and approaches, oriented legislation, in terms of harmonization with EU strategies and policies to achieve nearly zero energy buildings.

- Implementation of EU tools/instruments for sustainable building

- Existing training provision/capacity-building programs in sustainable materials, and/ or relevant areas.

To achieve these results, each project partner carried out its own desk research, based on the analysis of available resources produced by transnational, national and governmental institutions, professional organizations, statistical offices and training providers, such as: National sources provided by construction sector observatories, professional federations and research institutes (literature review of reports and policy papers), and EU sources selection (new European Bauhaus, Renovation Wave, Energy Performance of Buildings Directive (EPBD), the Energy Efficiency Directive (EED))

The desk research found out concrete answers and is provided Key conclusions reached, as well as recommendations for the training activity design to the following questions:

- Use of conventional building materials, their carbon, energy, and ecological footprint
- Definition of sustainable building materials (with a focus on recycled and secondary raw materials); including technological developments, and upcoming trends
- The status of the country's shift to sustainable materials and approaches, oriented legislation, in terms of harmonization with EU strategies and policies (e.g., EPBD, EED, building renovation passports, Energy Performance Certificates, Digital Building Logbooks, Smart Readiness Indicators), to achieve nearly zero energy buildings
- Implementation of EU tools/instruments for sustainable building (i.e., Level(s), ECO-Labelling, Green Public Procurement (GPP), BIM)
- Identification of institutional, technical, and organizational barriers and challenges for sustainable evolution and the use of sustainable materials in the construction industry
- Existing training provision/capacity-building programs in sustainable materials, and/ or relevant areas

All findings were validated and enriched with 6 national and 1 international roundtables. Their opinions and conclusions are also included in this handbook. These experts, who numbered more than 40 in total, were representatives of VET sector, construction industry and academia. Further information about each country's results from the desk research as well as from the national roundtables are found in Annex 1 and Annex 2.

2.2 Key areas of investigation in National context

2.2.1 Conventional building materials, their carbon, energy, and ecological footprint

Greece

Greece has 3.821.175 buildings of all uses (1990 inventory - National Statistical Office). The residential building represents 73,3 percent of the existing building stock. The age of the existing building stock where the 89,4% are constructed before 1981 and only 6,7% are constructed after.

Building material production in Greece uses mainly local, raw materials, which can be found within the country's borders (local markets). This results in low consumption of energy for transportation (20-30 km for distribution). The production processes are based on the combustion of fossil fuels and on electrical power. The sector generates an enormous quantity of construction waste and demolition materials and only a small part is recycled.

Waste from the construction sector in Greece (such as scrap metal, used cement or wood products) stood at 213 kg/capita or 2.3 tons in 2018 and represented 5% of total waste, the fourth lowest percentage in the EU-27 (36%).

The construction materials that are commonly used in Greece for residential and office buildings are reinforced concrete for the structural framework and brick & mortar for the internal and external walls.

Depending on the kind and uses of the structure, annual building energy consumption ranges from 60 to 500 kWh/m2. The amount of energy used annually for each purpose was calculated to be between 30 and 170 kWh/m2 for heating, 15 to 90 kWh/m2 for cooling, 10 to 50 kWh/m2 for lighting, and 10 to 80 kWh/m2 for the operation of various appliances and pieces of equipment. Depending on the type of structure, Thessaloniki's (in the northern region of Greece) annual energy consumption ranges from 375 to 156 kWh/m2 (one kWh/m2 equals approximately one lit of oil/m2/year).

The ranking of the most domestically sold construction products in Greece has changed over the 2010-2020 period. 'Portland cement, aluminous cement, etc., which ranked first in 2010, moved to second rank in 2020 and 'Ready-mixed concrete' (236310), ranking second in 2010, moved to first rank in 2020. 'Prefabricated buildings of metal', which ranked third in 2010, moved to fourth rank in 2020 and 'Articles of cement, etc.', ranking fourth in 2010, moved to sixth rank in 2020. Finally, 'Marble, travertine, alabaster, etc.', ranking fifth in 2010, moved to 14th rank in 2020.

Romania

In Romania, a wide variety of construction materials are used, of which the most used are as follows: concrete (plain, reinforced, pre-compressed); bricks (refractory, ceramic, anti-acidic); the steel; timber; polystyrene; mineral wool; limestone; ceramic tile; metal plates; OSB; wooden floor; PVC; fibre glass; the asphalt; screws and connecting elements; pipes and fittings; adhesives and paints; VOCs; polyurethane foam; silicon; rubber; plasterboard panels, etc.

According to the Order of Architects (OAR), Romanian residential buildings contain numerous construction materials, such as:

Concrete – represents more than 40% of the total construction materials;

Autoclaved cellular concrete - represents more than 25% of the total construction materials and competes with bricks;

Bricks – 15-20% of the total material used in construction;

The wooden structure used for less than 10% of Romanian buildings, especially for holiday homes in rural houses;

Polystyrene, a synthetic material commonly used as building insulation;

Gypsum board is the main material used for interior finishes;

Ceramic tiles and metal roofing tiles – metal tiles have gained a larger market share in the last 10 years due to their more affordable cost and ease of installation.

In the case of **commercial buildings**, the main material used is *metal* with more than 60% of the total volume of construction materials used and plasterboard for the interior.

Slovenia

Based on the multiannual national LIFE+ IP CARE4CLIMATE (2021-2026) project outputs, here is a summary:

The analysis is based on a review of the different construction products and in-depth interviews with stakeholders in the field. It is found that, of the construction products reviewed, currently just over 4% have Type I or Type III environmental labels. Most of the products with eco-labels reviewed come from the ranges of major international corporations and are marketed in markets where eco-labels have become a market obligation. The realization that the introduction of green public procurement has not had an impact on the increase in sales of eco-labelled products due to the specific criteria for sustainable construction. Demand for construction products is dictated by their price, which is also influenced by the additional costs of eco-labelling. Therefore, some companies (SMEs or micro producers mainly) do not apply eco-labels to all their products or have no interest in applying an eco-labelling system even if their products could meet the criteria. The conclusions recommend a number of different measures to promote the sale of products with eco-labels and highlight the advantages and disadvantages of different solutions.

The building products we use today come to us neatly packaged in boxes or on pallets and contain only the performance information you need to know - we do not need to tell you about the environmental impact of production. It is impossible to look at two steel beams and know which one contains recycled steel and which one is made entirely from new material extracted at high energy cost. It's also hard to tell which was made in a coal-fired blast furnace and which came from an electric arc furnace powered by renewable energy. The difference that this kind of detail makes in greenhouse gas emissions is huge and yet remains invisible. If you had this information, you could make a more informed decision, and that influences the markets. In Slovenia today, still not many investors ask manufacturers and suppliers for an Environmental Product Declaration (EPD) to install in their new buildings or for renovation purposes. It would be useful if at least some of the data from the EPDs were printed on the packaging (for physical buyers) to enable informed choice. EPDs, documents produced by conducting a life cycle analysis of a product. Producing an EPD is not mandatory, but few companies[1] choose to do so to demonstrate their commitment to the green agenda and to differentiate themselves in the marketplace.

Buildings using materials with EPDs have extra points in certification schemes such as LEED, BREEAM and the Irish Home Performance Index.

Unfortunately, till now no database of building materials/products neither of sustainable/green construction products in Slovenia has been established up yet. However, it will be set up within IPCARE4CLIMATE and designed according to the principles of the EOTA organization and another one limited catalogue on traditional construction products produced by the Slovenian building materials industry set up by Chamber of Commerce and Industry for its members and their support abroad, prepared within the Horizon project SEETHESKILLS[2]. There is a basic catalogue of environmental product declarations (Type III - Environmental Declaration (ISO 14025) at ZAG)[3] which is a useful tool for investors, designers and contractors.

[1] https://www.zag.si/certifikati-in-soglasja/izdane-okoljske-deklaracije/
[2] https://seetheskills.eu/why-use-seetheskills-materials-database/

[3] https://www.zag.si/certifikati-in-soglasja/seznam-tehnicnih-soglasij/

Republic of North Macedonia

Regarding the local databases of construction materials, there are no known records of materials nor EE materials Catalogue with widespread use in the construction sector.

There is clear evidence of the existence of many companies' databases in which there is reflected the construction materials information.

One of the most official is the internal database of the companies that are producers of construction materials and final construction products, hosted by the Association of Civil Construction, Building Materials and Non-Metals Industries within the Economic chamber of North Macedonia. This database of companies is closed for public search and is managed by the Building Materials Group, as part of the above-mentioned Association.

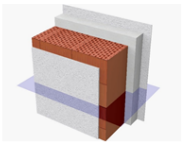
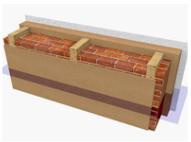
This entity shares information about domestic Building Materials Industry, which is based on domestic raw materials such as plaster, marl, ceramic clays, lime and other non-metal minerals, as according to the research deposits of these non-mineral raw materials will be available in the next fifty to one hundred years. The import of primary raw materials for production is almost negligible by the majority of manufacturers of building materials. The production of plaster products has undergone major changes with the introduction of new modern production lines and manufacturing of different range of plaster products, allowing fast and easy construction. Plaster products are usually placed on domestic market, but also on foreign construction markets (Albania, Serbia and Bulgaria).

Germany

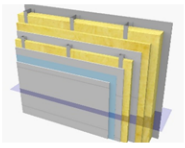
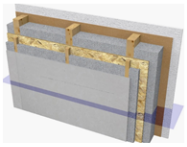
The ecological footprint covers the entire life cycle of the building from mining, processing and transport of the building materials, their installation and use to demolition or conversion.

The **Ministry of Economic Affairs, Energy, Climate Protection and the Environment in Saxony-Anhalt** used the "LENA Model House" to investigate the ecological footprint of conventionally and ecologically constructed buildings.

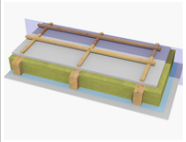
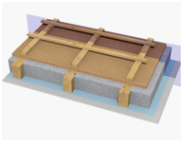
Ecological footprints: Solid exterior wall

Solid exterior wall (U=0,20 W/m²K)				
Conventional building materials (e.g. bricks, metals, glass) are characterised by high temperatures and energy consumption during production and should therefore achieve the longest possible lifetime.				
Construction method	**Conventional**		**Ecological**	
Building materials	Concrete, brick, lime, plastics, foamed plastic, rock and mineral wool		Natural building materials, wood, clay, cork, hemp, sheep's wool, reed, straw	
Examples		External thermal insulation composite system, synthetic resin plaster, 14 cm polystyrene board, 36 cm vertically perforated brick, 15 mm lime plaster		External thermal insulation composite system, adhesive mortar, 18 cm wood fibre board, 36 cm clay blocks, wooden pillars, clay plaster
Reference value	**Component 1 m²**	**Model house 100 m²**	**Component 1 m²**	**Model house 100 m²**
Primary energy	474 kWh/m²	47.400 kWh	334 kWh/m²	33.400 kWh
Global warming potential	147 kg CO_2Äqv./m²	14.700 kg CO_2Äqv.	6 kg CO_2Äqv./m²	600 kg CO_2Äqv.
Heat loss / year	16 kWh/m²	1.600 kWh	16 kWh/m²	1.600 kWh
Recycling	Recyclable through industrial reprocessing		Reusable, recyclable through industrial processes, thermally recyclable (incineration)	

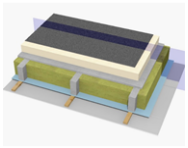
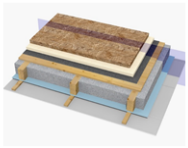
Ecological footprints: Exterior wall, lightweight construction

Exterior wall, lightweight construction (U=0,20 W/m²K)				
Metal stud structures with synthetic petroleum-based insulating materials (polystyrene, polyurethane) versus wooden stud structures with mineral and natural insulating materials				
Construction method	**Conventional**		**Ecological**	
Building materials	Metal framework, mineral fibre mats, plasterboard, plastics		Natural building materials, wood, clay, cork, hemp, sheep's wool, reed, straw	
Examples		External board fibre cement, 24 cm rock wool, metal framework, vapour barrier, gypsum plasterboard		Exterior plaster, wood fibre board, 20 cm timber frame, 8 cm cellulose, 6 cm wood fibre board, gypsum fibreboard
Reference value	**Component 1 m²**	**Model house 100 m²**	**Component 1 m²**	**Model house 100 m²**
Primary energy	157 kWh/m²	15.700 kWh	79 kWh	7.900 kWh
Global warming potential	40 kg CO_2Äqv./m²	4.000 kg CO_2Äqv.	-34 kg CO_2Äqv./m²	-3.400 kg CO_2Äqv.
Heat loss / year	16 kWh/m²	1.600 kWh/Jahr	16 kWh/m²	1.600 kWh/Jahr
Recycling	Raw material recycling, thermal recovery (combustion)		Recycable, thermal recovery (incineration), landfillable	

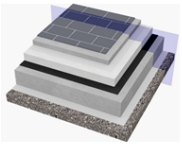
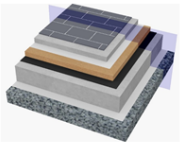
Ecological footprints: Pitched roof

Pitched roof (U=0,20 W/m²K)				
The production of roof tiles is energy-intensive and generates many greenhouse gases. Alternatives are green roofs or integrated solar roofs.				
Construction method	**Conventional**		**Ecological**	
Building materials	Concrete or clay roof tiles, wooden rafters with mineral wool, aluminium foil, gypsum plaster boards		Clay tiles, wooden rafters with wood fibre or cellulose insulation, gypsum plaster boards	
Examples		Roof tiles, battens, aluminium foil, Wood rafters, 22 cm mineral wool 035, vapour barrier, Gypsum plasterboard		Roof tiles, battens, wood fibre insulation board, Wood rafters, 20 cm cellulose 040 vapour barrier, gypsum plasterboard
Reference value	**Component 1 m²**	**Model house 80 m²**	**Component 1 m²**	**Model house 80 m²**
Primary energy	3.850 kWh/m²	308.000 kWh	120 kWh/m²	9.600 kWh
Global warming potential	1.075 kg CO_2 Äqv./m²	86.000 kg CO_2 Äqv.	-27 kg CO_2 Äqv./m²	-2.160kg CO_2 Äqv.
Heat loss / year	16 kWh/m²	1.280 kWh	16 kWh/m²	1.280 kWh
Recycling	Raw material recycling through industrial processes; thermal recovery (combustion)		Raw material recycling through industrial processes; thermal recovery (incineration), landfillable	

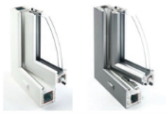
Ecological footprints: Flat roof

Flat roof (U=0,20 W/m²K)				
Construction method	**Conventinal**		**Ecological**	
Building materials	Reinforced concrete, rigid foam panels, mineral wool, roof sealing (bituminous, polymer)		Wooden construction, natural insulating materials, vegetation on roof	
Examples		Bitumen waterproofing membrane, 10 cm rigid foam panels, reinforced concrete beams, 20 cm mineral wool, wooden battens, gypsum plasterboard		Humus soil with vegetation, Bitumen waterproofing membranes, 10 cm rigid foam panels, wooden beams & boarding, 16 cm cellulose, vapour barrier, wooden battens, OSB boards
Reference value	**Component 1 m²**	**Model house 60 m²**	**Component 1 m²**	**Model house 60 m²**
Primary energy	165 kWh/m²	9.900 kWh	125 kWh/m²	7.500 kWh
Global warming potential	36 kg CO_2 Äqv./m²	2.160 kg CO_2 Äqv.	-30 kg CO_2 Äqv./m²	-1.800 kg CO_2 Äqv.
Heat loss / year	16 kWh/m²	960 kWh	16 kWh/m²	960 kWh
Recycling	Raw material recycling, thermal recovery (combustion)		Recycable, thermal recovery (incineration), landfillable	

Ecological footprints: Floor against ground

Floor against ground (U=0,35 W/m²K)				
High energy input in concrete production; new energy-efficient technologies are under development (certification)				
Construction method	**Conventional**		**Ecological**	
Building materials	Concrete, reinforced concrete, foam polymers, bitumen, ceramic tiles		Foam glass, concrete, reinforced concrete, natural insulating materials, bitumen, ceramic tiles	
Examples		Tiles, cement screed, PE foil, hard foam boards, bitumen sheeting, reinforced concrete, gravel fill		Tiles, cement screed, PE foil, wood fibre boards, bitumen sheeting, reinforced concrete, foam glass grave
Reference value	**Component 1 m²**	**Model house 60 m²**	**Component 1 m²**	**Model house 60 m²**
Primary energy	305 kWh/m²	18.300 kWh	302 kWh/m²	18.120 kWh
Global warming potential	85 kg CO_2Äqv./m²	5.100 kg CO_2Äqv.	70 kg CO_2Äqv./m²	4.200 kg CO_2Äqv.
Heat loss / year	< 25 kWh/m²	< 1.500 kWh	< 25 kWh	< 1.500 kWh
Recycling	Raw material recycling, thermal recovery (combustion)		Recycable, thermal recovery (incineration), landfillable	

Ecological footprints: Window frames

Window frames (U=0,95 W/m²K)				
Glass production is energy- and CO2-intensive. Triple glazing significantly reduces heat loss. Wooden frame windows have better eco-balances than PVC or aluminium windows.				
Construction method	**Conventional**		**Ecological**	
Building materials	Double or multiple glazed windows with frames made of wood, PVC, aluminium or other metals		Double or multiple glazed windows with frames made of local woods	
Examples		Aluminium profiles, polymer profiles, multi-chamber hollow profiles made of polymer, steel profiles		Domestic woods from sustainable cultivation (pine, spruce, larch)
Reference value	**Window 1,6 x 1,3 m**	**Model house 14 pieces (30 m²)**	**Window 1,6 x 1,3 m**	**Model house 14 pieces (30 m²)**
Global warming potential	520 kg CO_2Äqv./m²	15.600 kg CO_2Äqv.	440 kg CO_2Äqv./m²	13.200 kg CO_2Äqv.
Heat loss / year	80 kWh/m²	2.300 kWh	80 kWh/m²	2.300 kWh
Recycling	Household waste, partly hazardous waste; thermal recovery (combustion), partly re-usable (used glass)		Material separation, partially re-usable, thermal recovery	

Source: https://www.sachsen-anhalt-energie.de/de/modellhaus-baustoffe-bauteile.html

Italy

In recent years, the attention towards sustainable architecture has increased continuously: the goal is to reduce both the pollution linked to the construction of buildings and that relating to their subsequent use. The first fundamental step is to use sustainable materials for construction: the perfect material is the one that is not produced through a polluting process, which does not involve deforestation, which does not release harmful substances during use, which can be reused and recycled, and so on. saying.

Below are some of the most used conventional building materials in the construction industry in Italy:

Cement is one of the most used materials in construction and is also among the most polluting. In addition to not being recyclable, large quantities of energy are needed to produce it, which causes as many polluting emissions. Cement is created starting from limestone or gypsum, and therefore from raw materials based on calcium carbonate, and from clay, or from a material that contains aluminum silicates. These starting materials are first pulverized, and then fired at very high temperatures – up to 1,500 degrees. The result is an amalgam called clinker, which is in turn ground and mixed with gypsum. Thus, we have cement, which, once combined with water, starts the chemical reaction that we all know, at least superficially: the grains of cement in fact bind to each other, creating an extremely resistant lattice. Combined with sand and water, cement creates concrete. The heat treatment necessary to produce cement leads to considerable carbon dioxide emissions. As explained by the Global Cement and Concrete Association (Gcca), which represents about half of the global cement production capacity, «since the 1990s, emissions of CO2 for the production of materials have been cut by 20-30%».

Concrete is the most produced and used man-made building material in the world. Concrete is not exactly an eco- friendly material, because various aspects - linked to its life cycle - have a negative impact on the environment.

Steel was, and still is, the most used material in construction. The excellent mechanical resistance properties have chosen it over the years as the best product for the construction of load-bearing structures and frames. Steel is one of the most recycled materials. Italy is the 1st European country for the recycling of ferrous scrap with an average of about 20 million tons of material per year that is remelted in national steel mills.

Carbon fiber reinforced polymers have a negative environmental impact due to the fossil-based manufacturing process of the carbon fibers, and the inefficient waste recovery at the end-of-life phase.

Steel was, and still is, the most used material in construction. The excellent mechanical resistance properties have chosen it over the years as the best product for the construction of load-bearing structures and frames. Steel is one of the most recycled materials. Italy is the 1st European country for the recycling of ferrous scrap with an average of about 20 million tons of material per year that is remelted in national steel mills. Italy has the highest steel recycling rate within the European Union with 80% of recycled steel.

2.2.2 Sustainable building materials (with a focus on recycled and secondary raw materials); including technological developments and upcoming trends

Greece

In Greece, according to Law 2939/01 - Article 2: Secondary material: material which is the product of the processing of primary materials which have the status of waste.

Sustainable building materials are considered local materials, materials with low embodied energy, non-toxic materials and reused materials. There are various terms that describe these materials and the way they are built such as: 'clean materials' and 'clean building technologies', 'natural materials' and 'natural building' or “green” but there is no official definition in Greece for sustainable building materials.

Building materials typically considered "green" include timber from forests certified to appropriate forestry standards, rapidly renewable plant materials such as bamboo and straw, stone and its recycled products, soil, recycled metal, and other non-toxic, reusable, renewable and/or recyclable products.

The main legislation concerning sustainable building materials in Greece is Regulation 305/2011. According to this, constructions should be designed, built and demolished in such a way that they can be sustainable use of natural resources and in particular to ensure the following: the reuse or recyclability of construction works, materials and parts, the use or recycling of construction materials and their parts and components, the durability of construction works and the use of environmentally compatible raw materials and secondary materials in construction works.

Romania

One way to make concrete sustainable is to use industrial waste or by-products to replace the raw materials used to make concrete, such as cement and aggregates. Industry by-products used to replace cement are usually referred to as supplementary cementitious materials (SCM). Currently, blast furnace slag, fly ash, limestone powders, and silica fume are the most commonly used SCMs.

These SCMs can be obtained in large and regular quantities with a relatively consistent composition. They can be added to cement during the final grinding process of cement production to reduce the amount of clinker used, which was applied in Europe. They can also be added to the concrete mix during concrete production to reduce the amount of cement.

Glass is proving to be a very attractive building material, offering opportunities for the development of innovative, energy-efficient building envelopes. We also note that glass has an invaluable use in renewable solar energy technologies such as photovoltaic systems and solar thermal collectors. A unique combination of fascinating physical, optical, chemical, and thermal properties make glass a preferred construction material for modern buildings. Proper use of glass windows, doors, roofs, stairs, partitions, etc. makes buildings light, airy, energy efficient and also enhances occupant/user comfort. The most striking feature that contributes to the widespread use of glass in buildings is its transparency to visible light. Due to the absence of internal

subdivisions such as grain boundaries in the microstructure, glass does not scatter light and is therefore transparent.

Eco-bricks made from polyethylene terephthalate (PET) bottles filled with mixed inorganic waste have become a low-cost building material and a valid recycling method. This production process could be widely used to reduce or eliminate waste in regions where industrial recycling is not yet available. But these bricks, filled with mixed reclaimed materials, present a high fence of difficulty if we think about their recycling at the end of their life. However, if these PET containers are filled with a single inorganic waste material, they have a high potential for filling material recovery.

BCA - autoclaved cellular concrete is a building material very friendly to people and their health, because in its production no materials are used that harm health and do not release toxic gases in conditions of humidity or high temperatures. In addition, BCA can be made from 100% recyclable materials, which means it has no negative impact on the environment.

Polyurethane is a type of adhesive that has become popular in recent years, especially due to its ability to be environmentally friendly and provide a strong and durable bond.

Adhesives from renewable materials - there is a wide range of construction adhesives, made from various renewable materials, available on the market. These are eco-friendly products that are made from renewable and sustainable sources, so as to reduce the impact on the environment and provide a safer and more sustainable alternative to conventional adhesives.

Slovenia

Sustainable building materials are those that have a lower impact on the environment and human health throughout their life cycle. Recycled and secondary raw materials are considered sustainable building materials because they reduce the amount of waste that ends up in landfills.

Technological developments in sustainable building materials include the use of recycled plastic waste as a building material. This is because plastics are strong, durable, waterproof, lightweight, easy to shape and recyclable - all important properties for building materials.

Upcoming trends in sustainable building materials include the use of biodegradable materials such as bamboo and hemp. These materials are renewable and have a lower carbon footprint than traditional building materials.

A national database in Slovenia for building materials and products should be established and data collected from producers or certificates on fossil fuel consumption per unit of product in the production process, renewable energy consumption per unit of product in the production process, CO2 emissions per unit of product in the production process, etc. Without databases we will not be able to produce digital passports, implementation will be very difficult. Several European Union research and application projects have already produced databases for construction products that have been verified and good practice guidelines on digital passports are already available. It will also be necessary to provide databases on the environmental impacts of raw material extraction, materials and construction products processing and other supporting

databases, such as unique identifier sites, and to ensure compatibility of data structures with other relevant systems for the construction industry[4].

Republic of North Macedonia

In MK there is explicit distinction of sustainable materials from the conventional materials in the market offer, and the users do not clearly understand the difference between them, except for identifying the energy efficiency as a mark for sustainability.

The definition of sustainable construction materials is overall not very clear and in general there is no familiarity with the scope of sustainable construction materials.

Most common definitions have identified sustainable materials as materials that: have a long-life cycle and duration, are embedding less energy in their production, they are natural materials carbon neutral or produced by recycled material.

Speaking about the definition of sustainable materials, another issue are the parameters that need to be specified and certified about the sustainable material. According to the results of the answering poll, the following parameters are determining the sustainable materials: level of energy efficiency, possibility for recycling, duration, the cost, CO2 emission and the waste management, embedded energy for production and the skills for installation.

Germany

Sustainable building materials are those, that consume few fossil resources (e.g. petroleum), require little energy during processing, have a long service life and can be recycled or reused during demolition. They are particularly suitable for a small ecological footprint for buildings. Other factors that influence the result of the ecological footprint are for example, the location, cubature, orientation and tightness of the building, the technical systems and the energy used for heating, ventilation and hot water production. Comparable measured values are the energy input (primary energy) and the greenhouse gas emissions in the life cycle processes.

The use of used or recycled building materials is not entirely unproblematic in Germany. Reason: Building materials and components lose their so-called building authority approval after removal and may then not be reused as a rule. An example for this is removed gypsum boards, which are denied the suitability for fire protection and sound insulation. They may only be used where there are no fire protection requirements.

Another aspect of using used components is that they are free of harmful substances. Depending on the age and material of the components, a laboratory test may be necessary. Appropriate proof may have to be provided here.

[4] Source: https://topgradbenistvo.finance.si/9012678/Vstop-v-gradbeni-ekosistem-prihodnosti-EU-bo-mogoc-le-z-digitalnimi-potnimi-listi-proizvodov

In general, buildings in solid construction, as they are built today, can only be recycled due to their non-detachable connections, i.e., the components and building materials cannot be directly reused. In the case of demolition and new construction, it is therefore quite common for demolition contractors to set up shredding plants on the site to process concrete and bricks for subsoil preparation (so-called recycled gravel), for example. This "downcycling" is a way to save sand and gravel.

With solid timber construction, the situation is somewhat different, as the components and connections are detachable and can often be directly reused. However, static and/or building physics regulations must also be observed here.

However, it is difficult to reuse timber frame components that are glued to each other or to other materials. If possible, they are reused as a complete component[5].

Italy

Since there is no universally accepted definition of sustainable building material, we share the statement of Esin (2007) and Franzoni (2011): sustainable building materials are materials related to resource and energy efficiency in the production process and these materials should pollute less and have no negative impact on human health. It becomes apparent that sustainable building materials are related to the following criteria: resource efficiency, energy efficiency (including initial and recurring embodied energy and greenhouse gas emissions), prevention of pollution (including indoor air quality).

Italy has made significant progress in promoting the use of recycled and secondary raw materials in the construction industry in recent years. The government has implemented several policies and regulations to encourage the use of sustainable materials and reduce waste.

One of the key initiatives in Italy is the Green Public Procurement (GPP) program, which requires public institutions to prioritize the use of sustainable products and services, including recycled and secondary raw materials in construction projects. This program has helped to increase demand for sustainable materials and has encouraged the development of new recycling technologies.

The public sector, in fact, is called upon to solve the limits that hold back the development of the market for recycled aggregates, using incentives and streamlining procedures, trying to sensitize/train the contracting authorities on legal obligations. CAMs and GPP are tools that play an important role as an incentive.

As far as private construction is concerned, the Italian situation is, at present, quite varied. In fact, different models of environmental certification coexist. However, legal obligations are restricted exclusively to energy-related certifications.

[5] Source: https://www.dabonline.de/2022/01/05/gebrauchte-bauteile-recycelt-recyclingfaehige-baumaterialien-cradle-urban-mining/

Another important policy in Italy is the National Waste Management Plan, which sets targets for the recycling and recovery of construction and demolition waste. The plan aims to increase the recovery rate of waste materials to 70% by 2025, with a focus on the use of recycled aggregates in concrete and asphalt production.

Several Italian companies have also been at the forefront of developing innovative technologies for recycling and reusing waste materials in construction. For example, Italcementi, one of the largest cement producers in Italy, has developed a new type of concrete called active Biodynamic, which incorporates recycled materials and has a lower carbon footprint than traditional concrete.

The recycling industry in Italy has had constant and significant growth over the decades, which has led this country to be a European excellence.

According to official statistics, the recovery rate of construction and demolition waste, understood as preparation for reuse, recycling and other forms of material recovery, stands at 78% of the waste produced. But often, building materials left in warehouses or in any case not used on construction sites due to lack of competitive markets. To further complicate the situation there are critical regulatory issues. C&D waste has been subject to a very cumbersome and at times contradictory regulatory framework.

Overall, the use of recycled and secondary raw materials in construction is becoming increasingly important in Italy as the country seeks to reduce its environmental impact and transition to a more sustainable economy.

The recycling industry in Italy has had constant and significant growth over the decades, which has led this country to be a European excellence.

In addition to generating value, the recycling sector in Italy produces huge quantities of secondary raw materials, of great importance in the ecological transition process. There are 12 million and 287 thousand tons of metals, mostly steel; 5 million and 213 thousand tons of paper and cardboard; 2 million 287 thousand tons of chipboard panels; 2 million and 229 thousand tons of recycled glass; 1 million 734 thousand tons of compost and 972 thousand tons of recycled plastic. Overall, the production of recycled material increased by 13.3% between 2014 and 2020 (ISPRA, Rapporto Rifiuti Speciali 2021 e Rapporto Rifiuti Urbani 2021).

2.2.3 The status of the country's shift to sustainable materials and approaches, oriented legislation, in terms of harmonization with EU strategies and policies (e.g. EPBD, EED, building renovation passports, Energy Performance Certificates, Digital Building Logbooks, Smart Readiness Indicators), to achieve nearly zero energy buildings

Greece

In compliance with EU Directive 2010/31/EU, the assessment of energy performance is mandatory in Greece for new buildings and the sale or new leases of existing buildings.

Law 4342/2015 transposed the EED into national legislation and requires 3% of the total floor area of heated and/or cooled public buildings to be renovated each year to meet the minimum energy performance requirements.

The national plan for increasing the number of nearly zero-energy buildings was issued in August 2018 and defined, among others, that a new building may be characterized as a nearly zero-energy building if it falls at least under energy class A, while an existing building when it falls at least under energy class B+.

A very successful implementation of the EPBD in Greece is the program for energy renovation measures in the residential sector “Energy Savings in Households”. It is a national program that offers financial support, coming from structural and national funds, for interventions in the building envelope, the heating/cooling systems, and the installation of RES for DHW production. When first launched in 2011, the program provided subsidies ranging from 15% to 70 %, while the remaining investment was provided in the form of zero-interest loans. Due to its large acceptance rate, the program lasted until the end of 2016. The program includes buildings, which have a building permit and which are: located in areas with an average zone price lower than or equal to 2,100 €/m2, are for residential use and their owners meet specific income-related criteria.

Law 4067/ 2012 ‘New Building Regulation’, where Article 17 stipulates that for the construction of any building and the landscaping of the building surroundings, the provisions of the relevant legislation for alternative management of waste from excavation, construction and demolition waste should be applied are classified as low energy efficiency buildings.

From January 1, 2023, the Building Energy Performance Plan of par. 12 of article 7 of Law 4342/2015 (A' 143), includes the calculation of the carbon footprint of the buildings, according to the standard "ISO 14064-1:2018 ".

According to the new Greek Law 4685/2020 (Article 89), by the licensing procedure for a new activity construction or renovation of buildings, the obligated parties must provide a CDW management plan and a contract with an approved alternative management system (AMS) for the management of CDW in order to obtain the necessary building permit.

The utilization of secondary fuels from the cement industry, in the context of the industrial symbiosis and circular economy' between the Union of Cement Industries of Greece and the YPEN. The framework of the voluntary agreement defines the responsibilities of the Greek State and the Greek industry, cement industry and the specifications in order to increase the substitution of traditional fossil fuels. Duration of the agreement 7/2019 - 12/2023.

According to National Recovery Plan Greece 2.0, Under the Smart Readiness program, subsidies are provided for work on the installation of infrastructure that will facilitate the transformation of a building into a "smart" building by providing vouchers to cover part of the cost of the work.

Specifically, subsidized work includes: the installation of fiber optic networks within the building to facilitate the provision of high-speed broadband services to all areas of the building (apartments, offices, shops, etc.), the installation of infrastructure for the future interconnection of new 'smart' utility meters (electricity, gas) with the central hub of the building's electronic communications infrastructure, the installation of infrastructure for the future interconnection of the central heating boiler room and the lift machinery room with the central aggregation point of the building's electronic communications infrastructure.

The nominal value of the Vouchers is determined according to the type of work to be carried out and the specific characteristics of the buildings.

Greece also participates in the Horizon *iBRoad* project. The project worked on the concept of Building Renovation Passports, developing and testing a Roadmap for the renovation of a single building, and providing a 5–30-year renovation plan, tailored to specific needs. The roadmap is further supported by a building information repository (Logbook).

Romania

In Romania, the legislation regarding the sustainable approach to construction materials is based on the directives and regulations of the European Union in this field. First of all, the European Directive on the energy performance of buildings (EPBD) was transposed into Romanian legislation by Law no. 372/2005. This law provides obligations for both new and renovated or rehabilitated buildings from the point of view of energy efficiency, aimed, among other things, at the use of sustainable construction materials.

Also, Romania adopted Law no. 184/2020 on constructions, which includes provisions on the use of sustainable construction materials. This law sets strict rules on the quality and safety of materials used in construction and promotes the use of recycled materials and sustainable building materials in the construction process. Moreover, there are other regulations aimed at the use of sustainable construction materials, such as the Code of Practice for the Energy Efficiency of Buildings in Romania, which includes recommendations for the use of ecological and sustainable materials in construction.

Romanian legislation aims at a sustainable approach to construction materials through regulations that encourage the use of sustainable and energy-efficient materials. However, the implementation of these regulations can still be improved by promoting and supporting the use of sustainable building materials throughout the construction industry.

Slovenia

Digital passport for construction products

Manufacturers will need to think about what materials they use and how to optimize material selection, supply chains and production to minimize environmental impact. To achieve zero carbon and reduced environmental impacts by 2050, it will be necessary to change the linear consumer pattern of "take-make-use-dispose" and move towards a circular economy. The European Commission has set out action to address this in the context of the "Green Deal". Digital passports for construction products, or material passports, serve as an inventory of all materials, components and raw materials used in the process of making a construction product or building. Together with information on their location or origin and the flow of materials to the final construction product, we can also estimate the energy consumed, emissions and waste. Digital passports give materials a documented identity and a value-added footprint that allows them to remain visible in the supply chain throughout their life cycle.

The Digital Passport for Construction Products will be the gateway to the European Union market and a step towards digitizing the future construction ecosystem of the European Union. Designers, contractors and investors will use them to make decisions on the choice of materials, promoting more sustainable investment projects.

The digital product passport will also be referenced in sectoral legislation, as permanently recorded data can be used for calculations such as energy efficiency, Life-Cycle Assessments (LCA), and the data can be transferred to other building systems such as the Digital Construction Logbook, BIM libraries or digital twins of construction.

Slovenian manufacturers will need to accelerate their systemic thinking about what materials they install, their impact on the environment and people, how to optimize material selection, supply chains and production to minimize environmental impact. Above all, they will need to consider the entire life cycle of their products, even after their useful life has come to an end. The Digital Passport introduces a proposal for a Regulation on Eco-design for Sustainable Products, which will repeal the European Union Directive 2009/125/EC and establishes the concept of "sustainable product as a rule", as stated in a Communication from the European Commission. With this proposal, the Commission is also adopting a work plan for eco-design and energy labelling for the period 2022-2024.

By proposing a revised Regulation laying down harmonized conditions for the marketing of construction products, amending Regulation (EU) 2019/1020 and repealing Regulation (EU) 305/2011, as well as the aforementioned press release, the European Commission is making several points. Among other things, the revision of the Construction Products Regulation, together with the Digital Passport, will offer digital solutions to reduce administrative burdens, in particular for SMEs. This will include databases of construction products, offering a harmonized framework for assessing and reporting the environmental and climate performance of European Union construction products. It is difficult to estimate from public announcements when the Construction Products Passport and the revised Construction Products Regulation will enter into force.

A harmonized approach at European Union level will lead to a reduction in compliance costs and will, inter alia, simplify monitoring. In the proposal, the European Commission also mentioned that a further reduction of the administrative burden for manufacturers will be achieved by eliminating the overlap between the CE marking and the declaration of performance and that exemptions are foreseen for micro-enterprises operating exclusively locally.

The required production and maintenance of digital passports can create a significant burden and possibly even a barrier to entry into the EU market, especially for resource-constrained SMEs. Robust and flexible dynamic information systems for data management will need to be developed, which will not be possible to do in Excel alone, for example.

The development and maintenance of digital passports will therefore represent a significant investment in time and money, especially for SMEs. As the calculation methodologies will require the use of well-defined standards, the question of the pay ability of the standards arises, as this will be a significant obstacle for SMEs in the initial steps of adapting to the new requirements.

The development and deployment of digital passports requires the cooperation and coordination of multiple suppliers and supply chain stakeholders, which will lead to changes in the dynamics of supply chains. More information will lead to more accountability and trust between stakeholders, suppliers, buyers, public authorities and other stakeholders[6].

Energy performance certificates

Energy Performance Certificates exist in Slovenia and are in full use. Building owners are required to obtain an Energy Performance Certificate if the building (or apartment) is to be sold or re-let (for more than one year), unless one or more successive tenancy agreements with the same tenant are entered into after the expiry of a tenancy of less than one year, which would have a continuous duration of more than one year. A break of three months or less shall not constitute a break in the successive conclusion of the rental contracts. Owners of buildings who do not sell or rent out their property do not need an energy performance certificate. An energy performance certificate shall be issued for all buildings with a total usable floor area of more than 250 m2 owned or used by the public sector and the valid energy performance certificate shall be displayed in a prominent place. In buildings with a total useful floor area of more than 500 m2 , which are frequently visited by the public and subject to the obligation to issue an energy performance certificate, and which are not owned and used by the public sector, the valid energy performance certificate shall be displayed in a prominent position.

Digital Construction Log: not yet implemented Energy performance certificates must also be obtained for all new buildings.

Smart Readiness Indicators: covered by the Technical Guidance Document for Construction TSG-1-004:2022 required by the Energy Efficiency in Buildings Regulation.

Republic of North Macedonia

Regarding the legislation for SCM, there is NO explicit legislation on the use or requirement for use of sustainable materials. There is only a partial regulation of the usage of sustainable materials or that companies can only (by their own decision) follow the EU recommendations, as they are not mandatory in MK.

Germany

Construction Products Regulation

On 1 July 2013, the new Construction Products Regulation (CPD) replaced the Construction Products Directive (CPD), which had been in force since 1989, and is thus valid as a European regulation in all member states. Its aim is to remove barriers to trade in the internal market. The CPD regulates the conditions for placing construction products on the European market and

[6] Source: https://www.e-gradbenik.si/vsebine/gradbeni%C5%A1tvo/aktualno/digitalni-potni-listi-proizvodov/

establishes generally applicable requirements for the manufacturer's declaration of performance and the CE marking.

The basis of the Construction Products Regulation is the statement on the suitability for use of construction products, which is divided into seven core areas: Mechanical strength and stability, Fire protection, Hygiene, health and environmental protection, Safety and accessibility in use, Sound insulation, Energy saving and thermal insulation and sustainable use of natural resources. As referred:

- *The building must be designed and constructed in such a way that the energy consumption during its use is kept low. The building must also be energy efficient and consume as little energy as possible during its construction and deconstruction.*
- *The building must be designed and demolished in such a way that the natural resources are used sustainably and in particular the following is ensured:*
- *The building, its materials and components must be reusable or recyclable after demolition, the building must be durable, environmentally compatible raw materials and secondary building materials must be used for the building.*

Source: Baustoffkenntnis, 18. Aufl., S. 18.22 f; Bundesanzeiger Verlag

Building Regulation List

In Germany, the building regulations of the federal states (LBO) distinguish between regulated, unregulated and other building products. The classification is made according to the building regulation lists A, B and C; the author is the German Institute for Building Technology (DIBT).

A1: regulated building materials with standardisation and declaration of conformity,
A2: Unregulated building materials with general test certificate or approval in individual cases,
B: Unregulated building materials with CE marking,
C. Building materials with subordinate role without technical provisions.

Source: Building Rules List, A, Building Rules List B and List C; Edition 2015/2; Publisher: German Institute for Building Technology (DIBT); Berlin

Building Energy Act GEG

The Building Energy Act (Gebäudeenergiegesetz, GEG) has been in force since 1 November 2020. The German federal law replaces the Energy Conservation Act (EnEG), the Energy Conservation Ordinance (EnEV) and the Renewable Energies Heat Act (EEWärmeG) and thus brings together all energy-related requirements in one modern law. The aim of the GEG is the economical use of energy in buildings and an increase in renewable energies in building operation. From 2021

onwards, all new buildings are to meet the lowest energy standard, with the public sector acting as a role model[7].

Recycling Management Act

The Recycling Management Act entered into force on 1 June 2012. The purpose of the Act is to promote the circular economy to conserve natural resources and to ensure the protection of people and the environment in the generation and management of waste in order to strengthen the avoidance of waste, the already known and proven system of product responsibility was expanded to include the duty of care. The duty of care requires the preservation of the usability of products and allows their disposal only as a last resort. In order to improve the recycling of waste, the obligation to separate waste is to be strengthened. In addition, federal agencies and institutions in Germany will in future be obliged to explicitly give preference to products that are resource-conserving, low-waste, repairable, low-pollutant and recyclable when purchasing, provided that no unreasonable additional costs are incurred[8].

Promotion of new and existing buildings by Kreditanstalt für Wiederaufbau (KfW)

KfW[9] supports the changes in the economy and society on behalf of the Federal Government and the federal states. This is done through reduced-interest loans and subsidies for so-called energy-efficient houses 40. (The code number 40 indicates that the energy-efficient house requires only 40 % primary energy compared to a reference building (according to the Building Energy Act). In addition, the transmission heat loss is only 55 % of the reference building. The structural thermal insulation is thus 45 % better).

There are currently no subsidies for sustainability in the programme for existing buildings. Only subsidies for barrier-free conversion and burglar-proofing are available.

The use of sustainable building materials is not or only indirectly promoted.

Italy

The evolution towards high-energy efficient buildings is one of the most important challenges today and faces the goals of the Italian National Energy Strategy and the Integrated National Energy and Climate Plan.

The challenge for an increasingly efficient building stock and the goal development of a decarbonization to 2050 require multidisciplinary skills and in-depth knowledge from both a

[7] Source: https://www.baunetzwissen.de/glossar/g/gebaeudeenergiegesetz-geg-8143068

[8] Source: https://www.bmuv.de/gesetz/kreislaufwirtschaftsgesetz

[9] Source: https://www.kfw.de/kfw.de.html

regulatory and a technical-practical point of view. Italian legislation has established the obligation, by 2021, to build "nearly zero energy buildings" for all new or existing buildings undergoing major renovation, for which checks must be respected with respect to limit values calculated for the reference building (Ministerial Decree 26/6/2015). Furthermore, the obligations to integrate renewable sources must be respected in compliance with the minimum principles set out in Legislative Decree 28/2011.

Here are some of the key developments relating to the application of EPBD in Italy:

Energy performance certification: Italy requires the energy performance certification for all buildings, including new buildings, renovations and sales or leases. The certification must be performed by certified professionals and includes information on the energy performance of the building and recommendations to improve it.

Almost zero energy buildings (nZEB): Italy has set the goal of building all new buildings after 31 December 2020, almost zero energy buildings (nZEB). This means that they must have a very high energy performance and meet the minimum requirements for renewable energy sources.

Redevelopment strategies: Italy has developed a national strategy for the energy redevelopment of buildings, with the aim of improving the energy performance of the existing buildings. The strategy includes financial incentives and technical support for owners and managers of buildings to undertake improvements in energy efficiency.

Energy performance requirements for public buildings: Italy has set minimum energy performance requirements for public buildings, including schools, hospitals and administrative buildings. These buildings must meet the requirements of the EPBD directive and the energy performance must be exposed to the public.

Inspection of heating and cooling systems: Italy requires regular inspections and maintenance of heating and cooling systems in buildings to ensure that they work efficiently and effectively. This contributes to improving the energy performance of buildings and reducing energy waste.

Italy has set a national energy efficiency objective of 33.3% by 2030. The country has also introduced a series of measures to promote energy efficiency in buildings, such as incentives tax for energy efficiency interventions and the development of energy service companies.

Passports for the renovation of buildings: Italy actively promotes the use of passports for the renovation of buildings, which provide a complete overview of the energy performance of a building and suggest adequate renovation measures. The country has also established a fund to support the development of passports for the renovation of buildings.

Energy performance certificates (APE): Italy requires all buildings to have an energy performance certificate, which provides information on the energy efficiency of the building and recommendations to improve its energy performance.

Digital booklets of buildings: Italy is promoting the use of the digital registers of buildings to provide an updated registration of energy performance and the maintenance history of a building.

The country has developed a national platform for the digital registers of the buildings, which can be used by the owners and managers of the buildings.

Intelligent readers: Italy also promotes the use of intelligent readiness indicators, which evaluate the ability of a building to use new technologies to improve their energy performance. The country is currently working on the development of a methodology for intelligent readiness and requires them to implement them in new and renovated buildings.

In Italy, the National Portal on the Energy Performance of Buildings (PNPE2) was created, intended to perform an information and assistance function for citizens, businesses and the public administration. It is a tool that responds to multiple needs and offers a set of services in the field of energy efficiency.
It is also able to provide information and technical support to the Ministry of Ecological Transition and to the Joint Conference for the monitoring of national objectives on energy efficiency, for the integration of renewable energies in buildings, and for the elaboration of strategies and promotion programs relating to the energy requalification of the country's real estate assets. The portal is managed by ENEA and is available at the address http://pnpe2.enea.it/.

2.2.4 Implementation of EU tools/instruments for sustainable building (i.e., Level(s), ECO-Labelling, Green Public Procurement (GPP), BIM)

Greece

In Greece, the use of BIM is at an early stage. The only application of BIM having taken place at a national level was for the Stavros Niarchos Foundation. This pilot application was developed on a 3D model before the construction process started. However, it was not used, and the conventional approach was preferred. The Ministry of Infrastructure and Transport (MINE) is implementing a project to design a national strategy for Building Information Modelling (BIM) as part of its actions to promote digital transformation, which is a fundamental objective at the national and European levels.

BREEAM and LEED are internationally recognized systems that certify the degree of performance of a facility in terms of sustainability. Hundreds of thousands of buildings have been BREEAM or LEED certified in over 50 countries. The first building in Greece to receive BREEAM certification is the Greenstone Stamata, owned by AB Vassilopoulos SA, in 2012. Since 2012, according to SBC GREECE, there are 73 buildings that have received BREEAM or LEED certification. Most buildings are stores and offices.

Green public procurement (GPP) refers to the procurement of goods and services that have a reduced environmental impact. The National Action Plan for Green Public Procurement highlights that Green public procurement is an important policy tool for promoting sustainable building practices in Greece.

Romania

In Romania, the Law on the energy performance of buildings was adopted in 2013, which transposed the EPBD Directive into national legislation. This directive was actually transposed in Romania by Law no. 372/2005, which was subsequently amended by Law no. 159/2013. This law stipulates the obligation of building owners to obtain an energy certificate, as well as the obligation of public authorities to promote energy efficiency in their buildings.

The implementation of European and national tools for sustainable construction in Romania is an essential process for achieving environmental and climate objectives at the national and European level. In recent years, Romania has transposed a series of European directives into national legislation and developed policies and tools to promote sustainable construction.

Romania has developed the Guide to the design and execution of buildings with low energy consumption (RTC 4 – 2022), which provides recommendations and criteria for the design and construction of sustainable buildings. The guide includes information on thermal insulation, natural ventilation, the use of renewable energy, as well as other recommendations on the technical and practical aspects of sustainable construction.

Another important tool for sustainable construction is the Green House Program, implemented by the Ministry of Environment, Water and Forests (through the Environment Fund Administration, 2019, 2021, 2022). This program aims to finance projects for energy efficiency and the use of renewable energies in buildings and allocates funds to building owners who want to improve their energy efficiency.

Romania has also developed a voluntary certification system for sustainable buildings, called BREEAM (Building Research Establishment Environmental Assessment Method), which was already mentioned previously, being applied by Germany. This certification system aims to evaluate and certify sustainable buildings, considering aspects such as energy efficiency, use of renewable energy, stormwater, and waste management.

In addition to these instruments, Romania has also developed a series of policies aimed at promoting sustainable construction, such as the National Action Plan for Energy Efficiency (2017) and the National Strategy for Sustainable Development of Romania 2030 (2018). These policies include objectives and measures to improve the energy efficiency of buildings, reduce greenhouse gas emissions and promote the use of renewable energies.

Slovenia

The numerous efforts made in Slovenia in recent years to achieve the Sustainable Development Goals confirm the awareness of the importance of constructing sustainable buildings. In this area, we are confronted with market initiatives and incentive programmes for the implementation of national policy, as well as legal requirements in the field of construction and green public procurement. We therefore need a comprehensive system of sustainability criteria that introduces the principle of life-cycle thinking into the design and construction of buildings and that can be massively applied in the construction of buildings.

Under the umbrella of the huge national LIFE IP CARE4CLIMATE integral project (2019-2026)[10], led by the Ministry of Environment and Spatial Planning (MESP), GI ZRMK and ZAG, Slovenian sustainable construction indicators (kTG) are being developed:

The introduction of the sustainable construction indicators and related criteria will provide Slovenia with a transparent way to comprehensively assess the impacts of building construction and renovation at all stages of the life cycle, which will help to achieve important goals for the transition to a low-carbon society.

The alpha version of SLO CTG focuses on tracking three key pillars of sustainability: environment, people, and economy. Under the environment pillar, the system assesses energy consumption, material usage and waste production, water management, indoor air quality, and the building's resilience to climate change. It also considers cost optimization and building value. The system should encourage the use of methodologies and assessments that cover the whole life cycle of the building (LCA, LCC).

The sustainable building indicators are divided into 3 stages to allow users to start using the standard and later, as they become more familiar with the methodology, to use more detailed data that better represents their building project. Level 1 covers the conceptual design phase of the building. In stage 2, the detailed design and construction phase, the value of the indicators is calculated with more refined input data. In stage 3, the phase after construction is completed and the building is handed over to the client, the achievement of the calculated sustainable building indicators is monitored based on actual performance or measurements. Testing of the alpha version of the SLO kTG took place between November 2021 and May 2022. Planners, researchers, investors, students and other interested building professionals were involved.

Sustainable building certificates

In Slovenia, sustainable building certifications are DGNB, LEED, and BREEAM. The first project to receive DGNB certification in Slovenia was the "CENTER TIVOLI" in Ljubljana, in 2015. The "Knauf Insulation Experience Center" in Škofja Loka obtained DGNB certification in 2018. Subsequently, the "STRABAG Real Estate GmbH" and "DCO building" in 2022 also earned DGNB. Additionally, 10 buildings being in design process in 2023. The logistic centre Lidl in Žalec has received LEED certification in 2018 and Business building Vilharia in Ljubljana will receive in 2024. The Block of flats BRUSNICA in 2023 received BREEAM certification. Another building with BREEAM certification is the "Shopping center IKEA" in Ljubljana, certified in 2021.

Republic of North Macedonia

The status of use of tools for sustainable materials in North Macedonia

As an example of European EE materials catalogues, the website europages.es or europages.co.uk (The B2B sourcing platform) in English version shows the Construction material items, according to advanced searching, filtering existing materials on the database according to different filtering

[10] www.care4climate.si

fields. This database provides an interactive map for different kind of construction materials and enable search by countries.

After advanced searching for North Macedonia, no results were found in europages.eu database.

Regarding the local databases of construction materials, there are no known records of materials nor EE materials Catalogue with widespread use in the construction sector.

There is clear evidence of the existence of many companies' databases in which there is reflected the construction materials information.

One of the most official is the internal database of the companies that are producers of construction materials and final construction products, hosted by the Association of Civil Construction, Building Materials and Non-Metals Industries within the Economic chamber of North Macedonia. This database of companies is closed for public search and is managed by the Building Materials Group, as part of the above-mentioned Association.

This entity shares information about domestic Building Materials Industry, which is based on domestic raw materials such as plaster, marl, ceramic clays, lime and other non-metal minerals, as according to the research deposits of these non-mineral raw materials will be available in the next fifty to one hundred years. The import of primary raw materials for production is almost negligible by the majority of manufacturers of building materials. The production of plaster products has undergone major changes with the introduction of new modern production lines and manufacturing of different range of plaster products, allowing fast and easy construction. Plaster products are usually placed on domestic market, but also on foreign construction markets (Albania, Serbia and Bulgaria).

Germany

Agency for Renewable Resources e. V. (FNR)

With the independent specialist information on building, the FNR aims to reduce information deficits regarding climate protection, energy efficiency and sustainability in relation to building materials made from renewable raw materials.

The FNR's Building topic portal offers you well-founded information on building with wood and straw, on insulating with renewable raw materials and on finishing with natural and sustainable building materials. The offer is supplemented by a virtual construction site and a reference building database.

Virtual site: https://hausbau.fnr.de

Reference building database: https://referenzbauten.fnr.de (registration required)

Award and Contract Regulations for Construction Work (VOB/A)

The VOB/A (DIN 1960) contains the General Provisions for the Award of Public Works Contracts to be applied by contracting authorities and is divided into three sections (A, B, C). Section 1 of the VOB/A regulates so-called national construction contracts and thus has by far the largest

scope of application. "Green Public Procurement" (GPP) is characterized by the fact that environmentally relevant criteria are taken into account when awarding public contracts for products, services and construction projects. The VOB/A is mandatory for public contracting authorities and explains the rules according to which they have to award construction contracts. Private contracting authorities, on the other hand, do not have to apply the VOB/A; they can organize their award process more freely[11].

However, VOB/A for national awards does not provide any specific information on sustainability. This aspect is only mentioned indirectly:

The contract shall be awarded to the most economically advantageous tender. The basis for this is an evaluation by the contracting authority as to whether and to what extent the tender meets the specified award criteria. The most economical tender is determined by the best price-performance ratio. To determine this, qualitative, environmental or social aspects can be taken into account in addition to price or costs.

In addition, the VOB/A for requests for tenders within the EU states:

Life cycle costing includes all or part of the following costs: costs borne by the contracting authority or other users, in particular acquisition costs, usage costs, maintenance costs, and end-of-life costs (such as collection and recycling costs); costs arising from the externalities of the environmental impact associated with the performance during its life cycle, provided that their monetary value can be determined and verified; such costs may include costs of emission of greenhouse gases and other pollutants and other climate change mitigation costs.

Italy

Level(s) is a voluntary reporting framework developed by the European Commission which aims to improve the sustainability of buildings by providing a common language to assess and communicate their environmental performance. The framework focuses on six key sustainability indicators: greenhouse gas emissions, resource use, water use, health and comfort, life cycle cost and resilience. In Italy, Level(s) is used by several municipalities and construction companies as a tool to evaluate and improve the sustainability of their buildings.

Eco-labelling is another important framework for promoting sustainable building practices in Italy. Eco-labelling is a voluntary certification scheme that provides third-party verification of the environmental performance of building materials and products. The eco-labelling scheme in Italy is managed by the Italian Association for Industrial Research (AIRI) and covers a wide range of products, including paints, adhesives, insulation materials and flooring. Eco-labelling helps ensure that building materials and products meet strict environmental criteria, including the use of recycled and sustainable materials.

[11] Source: https://www.ibau.de

Besides these frameworks, there are also several applications of sustainable building practices in Italy. For example, the Italian Green Building Council (GBC Italia) is a non-profit organization that promotes sustainable building practices and has developed several rating systems to evaluate the environmental performance of buildings. GBC Italia rating systems include ITACA, a tool for assessing the sustainability of new buildings, and ITACA Protocollo, a tool for assessing the sustainability of existing buildings.

Overall, the use of frameworks such as Level(s) and ECO-Labelling, as well as the adoption of sustainable building practices in Italy, are important steps towards creating a more sustainable built environment.

Public procurement is a powerful tool that public authorities can use to stimulate demand for skills. By embedding criteria in tenders for certain certifications services, or qualifications, public buyers can send a signal to the market and encourage the development and learning of skills that support the transition to a greener economy. Procurers across Europe have started to embed skills requirements in tenders across a variety of product categories. Public procurement can be used as a strategic tool that can support the upskilling and reskilling of the workforce and help to futureproof the European Economy.

Building Information Modeling (BIM) is gaining more and more importance in the Italian construction sector, driven by several factors, including government initiatives, industry trends and technological advances.

In 2017, the Italian government passed a law mandating the use of BIM for public works projects (Decreto Ministeriale n.560 del 2017 -Decreto Baratono). The law requires all public housing projects with a value of more than €100 million to use BIM, and even smaller projects are encouraged to adopt the technology. This has resulted in a significant increase in the use of BIM in the country, especially in the public sector.

The Italian construction industry is also increasingly recognizing the benefits of BIM, such as improved collaboration, reduced errors and rework, and greater efficiency in the design and construction process.

Additionally, there are several BIM software vendors and training centres in Italy that are helping to support the adoption and implementation of BIM.

Overall, the use of BIM in Italy is growing, driven by government regulations, cost savings and improved project outcomes. The technology is being used in a wide range of construction projects, particularly by large enterprises and large public works projects. Much work still needs to be done to involve SMEs in the construction sector.

2.2.5 Identification of institutional, technical, and organizational barriers and challenges for sustainable evolution and the use of sustainable materials in the construction industry

Greece

Greece recycles less than 40% of construction waste compared to an EU average of 90% and EU target of 70%. The main barrier is the lack of awareness and education. Many builders, architects, and engineers in Greece lack awareness and education on sustainable building practices and materials.

Currently, the issue of BIM (Building Information Modelling) is limited to the representation of Greece to the EUBIM Task Group with two members: a representative of the Ministry of Environment and Energy and a representative of the Technical Chamber of Greece. The BIM implementation in public construction projects is allowed according to the Greek legislation (which has been adopted for harmonization with the EU Public Procurement Directive), there are no further requirements or guidance ensuring application in practice.

The country's weak innovation dimensions are the use of information technologies, finance and digitalization. Another major problem is the knowledge of the staff involved in the process of construction of sustainable buildings. The human resources in Greece are of a high level, but nowadays they need to adapt and become active in the dynamically changing environment of sustainable building. Delays in implementation and failures in the actual implementation of the European legal framework on the Circular Economy.

Romania

The main obstacles we identified are:

Lack of information and education among builders, designers and building owners about sustainable and durable building concepts, the high initial costs of sustainable construction, which are perceived as a major obstacle especially for real estate developers, lack of a coherent national strategy and policy to support the development of durable and sustainable buildings, lack of coordination between the various authorities and organizations involved in promoting durable and sustainable construction ,lack of clear standards and certifications for durable and sustainable construction to help increase trust and transparency in the market and withdrawal of investments in the sustainable construction sector due to legislative uncertainty or political instability.

The challenges faced by the interested parties in the field of construction are mainly:

The need to build durable and sustainable buildings at costs comparable to traditional building and the need to develop new capabilities and expertise among construction and designers.

Slovenia

In Slovenia, there are significant institutional shortcomings as there is no active support from any institution for the players and stakeholders involved in circular economy initiatives. Moreover, the Strategic Research and Innovation Partnership on Circular Economy (SRIPs)[12] lacks adequate

[12] https://www.gov.si/novice/2019-12-27-sprememba-javnega-razpisa-podpora-strateskim-razvojno-inovacijskim-partnerstvom-srip-na-prioritetnih-podrocjih-pametne-specializacije/

strength. The technical aspect also presents challenges as there are no available databases to facilitate the exchange of crucial information. Organizational barriers further hinder progress in the circular economy domain. One of the major challenges is the lack of funds to acquire eco-labeling type 1 and 3 certifications for their products, which affects their ability to meet sustainable standards.

Republic of North Macedonia

The major barriers and challenges for sustainable evolution and the use of sustainable materials in the construction industry can be grouped in five common factors: resistance/unwillingness to change, lack of green building experts/skilled labour, high capital cost, lack of building code and/or regulations and lack of government incentives and support (RII 5 0.893, ranked 5th). While the least ranked:
Factor 1 - Resistance and information barriers: Resistance/ Unwillingness to change, lack of information about green materials and products, low awareness of the benefits and other sustainability issues, lack of proper communication and coordination amongst stakeholders, poor education on sustainable design, the scarcity of environmentally sustainable materials

Factor 2- Regulation and funding of R&D: Lack of building code and regulations, lack of research funding for green building materials and technologies, lack of a standard GB tool

Factor 3 - Cost and market barriers: High capital cost, lack of client's Knowledge/market demand, lack of experience with GB methodologies

Factor 4 - Government incentives and Suppliers' availability: Lack of government incentives and support, limited availability suppliers of GBM, products and technologies, poor relationships amongst stakeholders

Factor 5 - GB Experts and labour barriers: Lack of green building experts/skilled labour, limited training on local green building materials, lack of firm understanding of sustainability concept

Germany

Building Regulation List

It is seemingly a contradiction that the Building Rules List regulates both the selection and the exclusion of certain building products. Accordingly, only brand-new building materials belong to the approved building products. If building materials or components are removed, they lose their approval and may then only be installed for subordinate purposes, e.g. coverings, coverings etc. When mixing with new material, a complete approval procedure must be gone through again (example: concrete with recycled old concrete):

For recycled aggregates and industrially manufactured aggregates except expanded mica (vermiculite), expanded perlite, expanded slate, expanded clay and brick chippings from unused bricks, the environmental compatibility must be proven with a general approval by the building supervisory authority.

Efforts are being made at European level to soften these regulations, but the idea of using recycled materials across the board has not yet gained acceptance in Germany.

Supply Chain Law

There is considerable resistance to the law in the construction industry. Although the law will only apply to companies with more than 1,000 employees from 2024, it is feared that it will subsequently be extended to small craft enterprises. Many statements and comments question how the law will be implemented for construction products. In its division of labour, the construction industry has to deal with numerous preliminary products and building products from all over the world. How is one supposed to know how the granite slabs were made, "whether or not women or children's hands were involved in slave labour"? A simple certificate from someone certainly does not help. On the other hand, one has to ask why no one has ever been interested in which upstream or downstream supplier was involved here. How can one find out without manipulation who was involved in the production?

It is feared that it is almost impossible for the construction trade to prove this.

It is complicated, if not impossible, for the construction industry to confirm who was involved in pre-production and under what conditions. A simple certificate is a paper that can be believed or not. Statements by the construction industry are ultimately evidence of powerlessness and of a failure of proof.

In summary, it can be said that it is above all the higher costs that make sustainable construction more difficult. In addition, a lack of knowledge among planners, contractors and clients is also cited[13].

Italy

Common barriers to change toward sustainability include:

- Economic development placed above meeting sustainability requirements in developing countries.
- Lack of support from policymakers.
- Absence of studies on sustainability.
- Lack of knowledge management.
- Lack of high-quality workmanship.
- Unfamiliarity with sustainable technology and materials
- Inadequate awareness of main aspects of ecological transition.
- Lack of sustainable product information.

[13] Source: https://bi-medien.de/fachzeitschriften/baumagazin/wirtschaft-politik/kommentar-die-bauwirtschaft-und-das-lieferkettengesetz-b14008

To overcome these barriers and challenges, it is essential to raise awareness of the benefits of sustainable materials and practices and provide incentives for companies to adopt them. This can include training programs, financial incentives, and regulatory frameworks that promote the use of sustainable materials and practices. Collaboration among stakeholders in the industry and the adoption of new technologies such as Building Information Modelling (BIM) can also help to improve sustainability practices and drive innovation in the industry.

2.2.6 Existing training provision/capacity-building programs in sustainable materials, and/ or relevant areas

Greece

An indicative list of existing training relative to sustainable materials is found below:

Title: Materials Science and Technology

Duration: 18 months

Type: Master's Degree

Level: 7

Institution: Department of Chemical Engineering of the National Technical University of Athens

Objective: Aim to train Engineers and scientists of other disciplines on conventional and advanced materials. This sector is a very important part of the national economy of a country (industry, small industry, crafts, etc.) and supports the development of other technical and financial activities (energy sector, construction industry, etc.).

Structure: The program has Specialization A "Materials Science" and Specialization B "Technology of Materials". Specialization A combines the subjects "Production- Structure-Properties-Applications' from a scientific point of view, while Specialization B mainly highlights its technological aspects.

Validation: University degree

Title: New Materials and Technologies in Structural Design

Duration: 18 months

Type: Master's Degree

Level: 7

Institution: Civil Engineering Department of DUTH and Civil Engineering Department of ATEITH

Objective: The aim of the program is the study of new materials and new technologies in terms of seismic design, the technology of concrete technology and interventions (repairs -

reinforcements) of structural works as well as the impact of the environment on building structures and structure the impact of construction and building structures on the environment.

Validation: University degree

Title: Reuse of buildings and sets

Duration: 24 months

Type: Master's Degree

Level: 7

Institution: Department of Architectural Engineering of the Polytechnic School of the University of Thessaly

Objective: The aim of the program is to organize comprehensive theoretical and practical research in the field of: the utilization with new uses of existing abandoned and obsolete shells, complexes, and areas and their renovation, structural and energy upgrades.

Structure: The structure of the program is as follows:

Modern Architecture in old buildings and historical ensembles

Impression and documentation of buildings and sets

Energy saving in existing shells

Workshop: New Architecture in Historical Environment - Recovery Strategies

Seminar: Imaging tutorial with 3d scanner

Static adequacy and reinforcement of existing shells, E / M installations in existing shells

Workshop: Reuse of buildings of anonymous traditional Architecture

Workshop 3: Industrial buildings - new uses

Workshop 4: Lectures by guests on the topic of implemented reuse projects

Seminar 2: BMS (Building Management System)

Seminar 3: BIM (Building Information Modelling)

Validation: University degree

Title: Construction Building Materials

Duration: 6 months

Type: Undergraduate degree

Level: 6

Institution: School of Architecture, National Technical University of Athens

Objective: Teaching is carried out in the Technical Materials Laboratory of the Faculty of Architecture, through lectures, experiments (bending, compression, tensile, hardness, abrasion, impact, water permeability, water absorption tests), as well as relevant laboratory exercises with the participation of students (composition and production of concrete, mortars and elements made of natural building materials, etc.).

Structure: Analysis of the main groups/categories of building materials: Wood and its industrial derivatives, Metals, Glass, Natural stones, Artificial stones, Mortars, Mortars (clay, structural lime, gypsum, cement), Concrete, Thermal insulation, Waterproofing and Soundproofing materials. The presentation covers all the basic properties of the above building materials (physical, chemical, mechanical, thermal, water, sound, fire, etc.), their production process and the relevant regulations.

Validation: University degree

Title: Environmental Building Design (class)

Duration: 6 months

Type: Undergraduate degree

Level: 6

Institution: Department of Civil Engineering of the Polytechnic School of the University of Patras

Structure:

European EPBD directive and national legislation. The NZEB building.

Regulation of Energy Performance Building and International Standards (ASHRAE, Passive House, etc.) / Introduction to Thermodynamics. Heat, Thermal Balance.

Energy Planning. Climate Parameters / Thermal comfort - Calculations, Specifications, Standards, Regulations.

Conventional, Bioclimatic Design, Renovation and Implementation Methodology.

Building Fabric. Thermal insulation. Elimination of thermal bridges. Air tightness, implementation of ISO 13829.

Frames, Glass, Specification (ISO EN 673, ISO EN 410, ISO EN 10077-2) and placement.

Heating and Cooling. Overheating during the Summer.

Ventilation and indoor air quality, Mechanical ventilation with energy recovery.

Energy balance. Software Calculations and Simulation. The use of RES in NZEB buildings.

The cost of renovation & construction.

Energy Retrofits in existing buildings: Regulations and Practices.

Technical specifications for buildings' energy efficiency measurements, Thermography, and Air Tightness Test. Building certification. Application examples.

Validation: University degree

Title: Training and Certification of Employees in the Construction and Materials Industry"

Duration: 20 months

Type: VET program

Level: 5

Institution: Funded by the European Social Fund (ESF) in the framework of the Operational Programme "Competitiveness, Entrepreneurship and Innovation 2014-2020" (EPAnEK) and managed by Panhellenic Association of Engineers Contractors of Public Works (PEDMEDE)

Objective: The program aims at developing professional capacity of 1.200 employees of the construction sector, through providing training and certification in the areas of BIM and Electronic Procurement for Public procurement.

Structure:

A. "SMART" Project and Construction Management - BIM

Importance of BIM for the study and construction of technical projects

Models of the technical design and construction industry

Areas of work that can affect BIM

BIM as a tool for contractors

Process of developing a BIM model by a contractor

Detection and reduction of design errors

Estimation of quantities and costs for submission of tenders

Construction analysis and design

Integration of cost control, schedule and other functions

BIM as a lever for market change

Steps of adoption of BIM in the process of production of components

Software compliant

Software environment

Design steps

3d illustration

B. "SMART" Planning and Management of Buildings Through Application Networks

The evolution and progressive development of "smart" energy devices and applications.

Basic energy management concepts and requirements related to energy planning.

Cost effective appliances and energy management standards.

Communication network technologies.

Local area networks - Internet of "smart" devices.

Ways and procedures of controlling the installations of "smart" systems

Building management system - BMS.

Analysis of intelligent building project management (BMS) functions.

Energy consumption and measurements.

Validation: Professional Certification

Romania

In Romania, non-governmental entities that promote the adoption of the principle of sustainability, both in terms of constructions and construction materials, and offer training programs to interested parties are active. Among these, we mention the Green Building Council Romania (RoGBC) and the Association for Excellence and Energy Efficiency in Construction (AEEEC).

Green Building Council Romania - is a non-governmental organization in Romania that promotes sustainable construction and certification of green buildings through assessment standards. Green Building Council Romania offers various training and certification programs for construction professionals who want to develop skills in sustainable approaches to building materials.

Association for Excellence and Energy Efficiency in Construction - is a Romanian organization that promotes energy efficiency and sustainable construction through assessment and certification standards. The Association for Energy Efficiency in Construction offers various training and certification programs for construction professionals who want to develop skills in sustainable approaches to building materials.

We note that most large/major companies operating in the construction industry have their own training programs on sustainable construction and building materials. Regarding the formal system, Romania is in the process of adapting the training programs and the curriculum to the new requirements, but the progress made so far is extremely small and punctual. Thus, it follows that the need to increase the response capacity of the VET sector, and not only, to the needs of the labour market, for the field of constructions is vital for achieving the objectives of sustainable development.

Slovenia

Slovenia offers a range of valuable training opportunities within the context of various projects, each contributing to the advancement of knowledge and skills in specific areas. IP CARE4CLIMATE project[14] offers training courses. Also, the project GUPP Academy project[15] and BUNG nZEB game-based learning application[16] provide training courses. Moreover, the IJS Centre Projects[17] and ZAG projects[18] offer training related to this field.

Republic of North Macedonia

There are very few training opportunities for sustainable materials in MK and they are partially related to the awareness or the benefits on sustainable materials. Several examples are:

- The training: "Advisor of sustainable development"[19],
- School for sustainable development[20],
- Green Economy and Sustainable Development[21],
- Introduction to Sustainability in the Construction Sector[22],

Also, there are an isolated examples of the in-company trainings for installation of products that can be marked as sustainable materials.

Germany

Green Growth[23] developed a MOOC (Massive Open Online Course) to contribute to the lifelong learning of construction trainers, offering a transversal approach to the Circular Economy and fostering a wider dissemination and application of European principles to the construction sector.

[14] https://www.care4climate.si/sl/dogodki

[15] https://gupp.gzs.si/

[16] https://www.bung-project.eu/

[17] https://ceu.ijs.si/kdo-smo/

[18] https://www.zag.si/raziskave-in-razvoj/raziskovalni-projekti/domaci-projekti/

[19] https://ecologic.mk/the-training-advisor-of-sustainable-development/

[20] https://ecologic.mk/school-for-sustainable-development/

[21] https://www.seeu.edu.mk/en/faculties/be/be-study-programmes?id=247

[22] https://iege.edu.mk/education/introduction-to-sustainability-in-the-construction-sector/

[23] https://greengrowthproject.eu/cursos/

Courses:

INTRODUCTION: Circular economy in construction.

MODULE DE FORMATION 1: Embodied energy in the construction industry.

MODULE DE FORMATION 2: LEVEL (S): European framework for sustainable buildings.

MODULE DE FORMATION 3: BIM and sustainable construction.

MODULE DE FORMATION 4: Materials, how to use/guide to sustainable materials. MODULE DE FORMATION 4: Materials, how to use/guide to sustainable materials.

MODULE DE FORMATION 5: Reuse in construction.

Construction Blueprint includes a range of FREE, easily accessible online courses in the categories of energy efficiency, circular economy and digitalisation. The e-learning platform aims not only to support potential new entrants to the industry, but also to give existing workers the opportunity to expand their knowledge and thus advance their careers[24].

Italy

In Italy, several training and capacity building programs are available for professionals and stakeholders in the construction sector related to sustainable materials and relevant areas. Some examples of these programs include:

Sustainable Building Training Program: This program is offered by the Italian Green Building Council (GBC) and focuses on training architects, engineers and other building industry professionals in sustainable building practices and materials.

Sustainable materials training programme: The Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) offers training on sustainable materials, with a particular focus on the use of eco-friendly materials and products in construction.

Green Building Professional Certification: The Italian GBC offers a certification program for building industry professionals who demonstrate knowledge and experience in sustainable building practices, including the use of sustainable materials.

Energy Efficiency Training Programme: The Italian government offers a range of training programs related to energy efficiency in buildings, including the use of sustainable materials and energy-efficient building design.

These programs are essential to enhance knowledge and skills among construction industry professionals and promote the adoption of sustainable practices and materials.
The vocational training segment may be the best context to offer capacity-building programs in the field of sustainable construction for all profiles of the construction industry.

[24] https://constructionblueprint.eu/de/onlinekurse/

In this context, however, it is necessary to expand the training offer and make it known to the reference target.

2.3 Transnational key findings

Key findings which are concluded from literature review provided about construction materials and practices in participating countries (Greece, Romania, Slovenia, North Macedonia, Germany, and Italy):

- Sustainable building materials vary in definition across countries, but common themes include local sourcing, low embodied energy, non-toxicity, and reuse.
- There is a lack of awareness and education among builders, architects, and engineers hinders the adoption of sustainable building practices and materials.
- Lack of coherent national strategy are barriers to sustainable construction. Countries with well-defined strategies and policies tend to have better coordination, clear standards, and certifications, which contribute to the growth of sustainable construction practices.
- Barriers include resistance to change, lack of green building experts and knowledge, high capital costs, absence of building codes and regulations, and lack of government incentives and support.
- The lack of qualified personnel in the construction execution phase, who know environmentally friendly materials and execution principles, for an increased energy efficiency of buildings.

3. Liaising with the VET, the educational sector, the academia, the industry for identifying the utmost potential of sustainable building materials

3.1 Content/Aim

The aim of this activity was to exchange views and knowledge with key stakeholders and VET representatives towards the potential of sustainable building material, skills and competence gaps as well as recommendations for the sustainable building materials VET curricula. The primary objectives of the activity were as follows:

- To raise awareness on environmental impact of (conventional) construction materials, as well as introduce policies, initiatives, innovations and technologies related to sustainable building materials.
- To facilitate networking and boost synergies, transnational cooperation among key stakeholders and among the partnership in order to align competence needs with the industry's demands.
- To engage stakeholders with Sustainable practices and use of materials in the construction sector in the pathway of a climate change resilient and sustainable

transition.

For this purpose, 6 national interaction roundtables were held in national context, involving minimum 6 key stakeholders per country. They were organized utilizing common guidelines, methodologies and questionnaires including open questions, in all partner countries, in order to allow high comparability of results and conclusions.

3.2 Participants profile in terms of type of organizations, services provided and main target group

A series of roundtable discussions were conducted across different countries as part of the European Erasmus+ Building Matters project. The aim of these discussions was to exchange views, knowledge, and experiences regarding sustainable building materials and address skills and competence gaps in the construction sector.

In Greece, a roundtable event hosted by PEDMEDE aimed to build capacity and raise awareness of sustainable building materials in the face of climate change risks. 10 key stakeholders from the construction sector shared their experiences and proposals. The majority of participants were male civil engineers, mechanical engineers, and technical professionals. In Romania 19 representatives from companies producing building materials, construction and installation consulting firms, educational institutions, social partners, and construction research institutes participated in the roundtable. In Slovenia, the event involved 9 representatives from various stakeholders, including construction companies, the national standardization body, the national construction institute, and a vocational school. The participants were a mix of male and female civil engineers and technical professionals. The roundtable in the Republic of North Macedonia involved 17 key stakeholders, including chambers of commerce, building material manufacturers, a large-scale construction company, construction entrepreneurs, and an academy. In Germany, 21 participants, all male, took part in the roundtable discussions. They consisted of skilled workers, including bricklayers and concrete builders, employed in both large corporations and small to medium-sized companies. Additionally, project managers and an entrepreneur from the construction industry also participated. In Italy, a roundtable discussion was attended by 6 experts with expertise in various areas related to construction, including construction techniques, environmental sustainability, energy efficiency, and more. These experts collaborate with Banca della Calce, contributing to the development of courses and events dedicated to the use of sustainable materials in construction.

Additionally, 1 joint transnational Interaction roundtable with representatives from VET and construction industry were conducted in order to conclude to joint recommendations for the inventory of sustainable building materials and for training design curricula. The participants were experts from construction industry and academia. 16 key stakeholders involved to this roundtable. These roundtable discussions provided an opportunity for stakeholders to share

insights, best practices, and opinions on sustainable building materials, helping to bridge skills gaps and align VET curricula with industry demands.

3.3 Identification of institutional, technical, financial and organizational barriers, needs, challenges and opportunities for sustainable evolution and the use of sustainable building materials

Greece

There are several technical, legal, institutional, and financial challenges and barriers to achieving sustainable evolution in construction, the use of sustainable materials, and achieving carbon-neutral goals in Greece. As referred by the participants:

Technical barriers are the lack of knowledge and expertise in sustainable building practices. More education and training are required to assist architects, engineers, and builders in comprehending sustainable construction best practices in order to be commonplace for all of them.

Legal barriers: In Greece, the legislation is chaotic and the implementation of EU regulations to Greek law is problematic and not well-structured so there is a need for more supportive regulations in order to promote sustainable building. Furthermore, there are no significant incentives to incorporate sustainable building materials.

Institutional challenges: a lack of coherence in policies and regulations which makes the implementation of sustainable building materials really challenging.

Financial challenges: Sustainable construction and the use of sustainable materials might be more expensive than conventional construction practices. Customers prefer not to burden with this additional cost. As a result, the use of conventional building materials.

Romania

The degree of awareness of how to calculate the carbon footprint in the construction and building materials market is very low. There is controversy regarding how to calculate the carbon footprint, caused by the manufacturing process and the use of various construction materials. Efforts are currently being made to standardize a calculation methodology that covers the entire manufacturing and use process of construction materials (starting from the raw material, supply lines, technological process, sales line, transportation, etc.).

Barriers, opportunities, and challenges (technical, legal, financial, and institutional):

The high costs of high-performance and environmentally friendly materials; lack of appropriate technologies for recycling and re-introduction into the waste production process; inconsistencies between the legislative framework and the provisions of the STAS and technical regulations regarding construction materials; lack of legal provisions on public procurement to stimulate green procurement; lack of specialists in the concept and design phase of constructions who know and apply the principles of circular economy and energy efficiency of constructions; lack of

qualified personnel in the construction execution phase, who know environmentally friendly materials and execution principles, for an increased energy efficiency of buildings.

Most of the financial allocations regarding public investment projects did not provide mechanisms for financing environmental actions, although they all have sustainability requirements.

Slovenia

A number of different technical, legal, institutional and financial challenges and barriers to sustainable development in construction was identified. The use of sustainable materials and products and the achievement of carbon neutral construction targets in Slovenia. As identified by the participants:

Technical barriers: Unfortunately, there is no single national catalogue of green/sustainable building materials, with the exception of the register of issued EPDs for construction products (eco label III) at ZAG[25], which would help decision-makers and designers to select the concepts and materials used in the building process. Many self-employed architects also do not find the time and resources for lifelong learning. The state will certainly need to do more to tighten up on the exploitation of natural resources and limit new construction in favour of renovation and replacement.

Legal barriers: Generally, sustainable construction is encouraged through the green public procurement mechanism, but when this is deliberately avoided by public bodies, the law does not sanction it but penalizes it. Unfortunately, investors/contractors also do not explicitly express their interest in sustainable construction and the use of sustainable materials, as they are not rewarded for it, while traditional construction is still financially more profitable. The absence of a consultation phase in the process of preparing a public procurement contract: as this process is not mandatory, many contracting authorities avoid it and do not check the market situation and design and publish a public tender - a call for tenders to which the business entities or public law entities for which the support in the public tender was intended cannot respond. Evaluation of the time and resources wasted on a failed (thematically misguided) public call for tenders is unfortunately not carried out.

Institutional challenges: lack of policy and regulatory coherence, making the adoption of sustainable building materials a major challenge. Lack of awareness of the issue at local and regional level, especially among private individuals and entrepreneurs. Lack of good practices and information on the experiences of actors who have already built such a building.

Financial challenges: Sustainable construction and the use of sustainable materials are less known and companies lack experience and staff trained in the use of these materials. Sustainable construction is generally more expensive than conventional building practices, but this is not even true for less sophisticated buildings such as privately owned family homes. Currently, the National

[25] www.zag.si

Eco Fund promotes energy-efficient construction through grants and loans to private individuals, public institutions and companies, but not the installation of sustainable materials and products. Most small and medium-sized enterprises are not able to bear the costs of expensive environmental certificates, and only 5 % of all building products in the Slovenian building materials industry have an environmental declaration.

Republic of North Macedonia

First of all, the most dominant barrier is the lack of awareness. The overall score of the level of awareness of the meaning and the benefits of sustainable construction materials is 2.3 (on the scale of 1-5). In this score, the half of the respondents had answered that they evaluate the level of awareness with the score 2, while only 8% have given the score 5 for the level of awareness. This result identifies the low level of awareness as the major challenge for more intense sustainable evolution in construction. As the additional barrier, not existing legislation and the demand side is not less important to be mentioned.

Germany

Two focal points emerged from this question (multiple answers were possible): the higher costs for sustainable building materials (10 participants) and the knowledge gaps among planners and contractors (7 participants).

Legal obstacles were mentioned twice (national fire protection regulations and misleading or missing national standardization or testing, e.g. for recycled concrete).

Only once each were mentioned: technical difficulties (lack of knowledge about application areas and limits) and lack of availability of sustainable building materials.

In Germany, the use of building materials seems to be regulated by law, but no law explicitly defines what sustainable building materials actually are (exception: the federal state of Bavaria explicitly defines building with wood as sustainable). Several associations are trying to close this gap. The biggest challenge in Germany is the use of recycled building materials, for which there are hardly any technical building regulations, standards or application descriptions (exception: recycled gravel; recycled steel, glass and plastic products are regulated, but are of little relevance to the building trade.

The costs for sustainable building materials appear too high for the customer and the planner (there is no increased payment for sustainable construction), demand is still low but seems to be gradually increasing. The reason for this is the increasing preoccupation of customers and planners with sustainability, often triggered by media alert messages (shortage of raw materials, environmental disasters, climate crisis).

Italy

As referred by the round table participants, the challenges and barriers can be broadly categorized into four areas: technical, legal, institutional, and financial.

Technical challenges and barriers:

Lack of technological innovation: The construction industry has been slow to adopt new technologies that can reduce the carbon footprint of buildings. Many existing technologies, such as energy-efficient lighting and HVAC systems, are not widely used due to their high cost.

Limited availability of sustainable materials: The availability of sustainable materials is limited, which makes it difficult for builders and architects to design and construct buildings that are sustainable. This is due to a lack of research and development in sustainable materials and the cost of producing them.

Building codes and regulations: Building codes and regulations often do not prioritize sustainability, and many of them are outdated. This can make it difficult for builders and architects to implement sustainable practices.

Legal challenges and barriers:

Regulatory hurdles: There may be regulatory hurdles to overcome in terms of permits, zoning, and building codes that hinder the use of sustainable materials or innovative construction methods.

Liability concerns: Builders and developers may be concerned about the potential liability associated with using new, untested materials or construction techniques.

Institutional challenges and barriers:

Lack of industry-wide standards: There are no universally accepted standards for sustainability in the construction industry. This can make it difficult for builders and architects to make informed decisions about sustainable practices.

Resistance to change: Some people within the construction industry may be resistant to change, especially if it means higher costs or a change in the way they have traditionally done business.

Financial challenges and barriers:

Cost: Sustainable building practices and materials can be more expensive than traditional methods and materials, which can make it difficult for builders and developers to justify the investment.

Lack of financing options: There may be a lack of financing options available for sustainable building projects. Banks and other financial institutions may be hesitant to provide loans for projects that are perceived as risky or untested.

3.4 Familiarization with the National and EU strategies related to sustainable building materials, energy efficiency or relevant topics

Greece

The vast majority of participants mentioned that they are more familiar with the legislation regarding energy efficiency and energy consumption for buildings. Most participants mentioned that have knowledge regarding the Energy Performance of Buildings Directive (EPBD) and the nearly Zero Energy Buildings (nZEB) standard. As existing building stock in Greece are old, the participants refer that their works are highly related to the renovation and energy efficiency upgrade of buildings. They also have knowledge about the New European Bauhaus movement. The Energy Saving at Home program was one of the main programs regarding the energy efficiency upgrade for houses.

Additionally, the stakeholders referred that they use certification as BREEAM and LEED systems which are systems that certify the degree of performance of a facility in terms of sustainability.

Most participants referred that the use of energy-efficient windows and doors to improve thermal insulation and reduce energy consumption and also more eco-friendly materials for insulation.

Romania

From a legislative point of view, Romania has a high degree of adaptation to European and international regulations. Also, efforts are being made at the level of professional organizations and responsible factors (ministries, certification bodies, etc.) to adapt product standards and technical prescriptions.

Actors on the construction market are aware of the European and national regulatory norms regarding construction materials and in this sense, they make efforts to align with the new normative requirements.

Slovenia

Participants said they pinned their hopes on the recently established Hub for sustainable building renovation and construction. The Hub was launched on 28 November 2022 at the House of the European Union with the aim of bringing together a wide range of stakeholders who want to achieve the widest possible dissemination of sustainable building renovation and construction in Slovenia. Several international projects are also underway to facilitate access to finance to get sustainable construction off the ground (ESIF network, SMAFIN, RENOINVEST, CARE4CLIMATE project). They are also working to bring stakeholders together and move society and business towards more carbon neutrality as quickly as possible.

Certainly, all stakeholders are more familiar with legislation on energy efficiency and energy consumption in buildings than with sustainability and eco-design. Most participants mentioned that they are familiar with the Energy Performance of Buildings Directive (EPBD) and the Nearly Zero Energy Buildings (nZEB) standard, especially since both private and public building investors

have been financially supported by the national eco-fund through public tenders for several decades. Many hopes rest on the new proposal for a new Eco-design Regulation for sustainable products (Eco-design Directive 2009/125/ EC), published on 30 March 2022, which is the cornerstone of the Commission's approach to more environmentally sustainable and circular products. Its adoption and national implementation will be very important.

It is also disappointing to learn that the eco-label for the best construction products and services, the Construction Quality Mark, CQM, is not better known and accepted by companies than by customers. It is awarded to a maximum of 3 companies every year at the regional construction fair Megra, which is far too few. The CQM Environmental Certificate can only be awarded to products, services, equipment and technologies that have achieved a sufficient score in each category in the comparative assessment/evaluation. This label establishes a system for evaluating products and services in the construction sector. It can help contracting authorities and consumers to make an investment or procurement decision more easily and professionally. It also allows applicants in the assessment process for the label to compare themselves with their competitors. With the ZKG project, GI ZRMK in Slovenia aims to encourage and guide manufacturers and contractors on the path to quality, investor and user satisfaction and thus business success, but unfortunately the process to obtain a national eco-label is too costly and does not pay off for the applicant through newly acquired projects in the market. Unfortunately, the eco-label has not been sufficiently promoted and demanded in public tenders. Perhaps the proposal for new (admittedly optional) guidelines for public procurement in construction is an opportunity to improve the situation at national level.

Republic of North Macedonia

Regarding the legislation for SCM, 1/3 of the respondents share the opinion that there is only a partial regulation of the usage of sustainable materials or that companies can only (by their own decision) follow the EU recommendations, as they are not mandatory in MK. There is also opinion by 18% of the respondents that the use of sustainable construction materials is not regulated at all. But the common finding by almost all respondents 96% is that the updating regulations and introducing strict legislation on the use of sustainable construction materials is more than necessary.

Germany

The results on this point are also very different. 8 participants clearly answered no, 6 participants did not know. Nevertheless, 7 participants stated that their company deals with the national and EU requirements. However, only two participants could explain how this is done: on the one hand, knowledge is acquired by studying legal texts, supported by a legal department (in the large company). Secondly, the entrepreneur is personally committed to acquiring knowledge because sustainability is a personal need for him.

In summary, there seems to be a lack of in-house transparency and communication in Germany. The 14 out of 21 answers (no or don't know) can hardly be explained otherwise. However, a lack

of interest or too high workload (statement: I have completely different worries) in the companies may also be a reason for the deficit.

Italy

All the experts declared themselves familiar with the national and EU strategies related to sustainable building materials, energy efficiency, energy performance certificates, smart readiness indicators, GPP and other similar topics.

Several training and consultancy activities they are involved in provide knowledge and skills on the topics indicated above with different levels of detail based on the type of course and the recipients involved.

3.5 Main issues, needs and challenges in the use of sustainable building materials in relation to conventional ones

Greece

Despite the fact that there are some initiatives regarding sustainable building materials, most constructors in Greece still use a small number of sustainable building materials, while the great majority of construction projects still use conventional materials.

The participants believe that this is due to clients not being aware of sustainable building materials and a lack of knowledge about how buildings may promote environmental protection and aid in achieving climate-neutral goals. Moreover, there is a shortage of new building projects and customers want to keep the cost down. Another issue is the fact that most customers believe that sustainable building materials are not as durable as conventional ones and are more expensive.

Also, another main issue is the lack of expertise among builders regarding the use of sustainable building materials and the fact that there are no certified construction workers in sustainable building materials and practices.

Romania

The end market (beneficiaries) of construction materials is very reluctant to use recycled materials or new materials that have a proportion of recycled materials in their composition, mainly due to the pre-conception that they are of a much lower quality.

Lack of confidence in the economic value and sustainability of construction materials that incorporate or are produced based on waste. This lack of confidence starts mainly from the price/quality ratio.

Slovenia

The realization that the introduction of green public procurement has not had an impact on the increase in sales of eco-labelled products due to the specific criteria for sustainable construction. Demand for construction products is dictated by their price, which is also influenced by the additional costs of eco-labelling. Therefore, some companies (SMEs or micro producers mainly) do not apply eco-labels to all their products or have no interest in applying an eco-labelling system even if their products could meet the criteria.

Republic of North Macedonia

Level of awareness for sustainable construction materials in general is as low as 2.3 (on the scale of 1-5). This specific impact on the environment that the sustainable materials are providing is not well understood, and currently, only the energy efficiency if considered as the main benefit of SCM.

There is an utmost need for training on the topic for raising the awareness of the meaning, the benefits and the impact of sustainable construction materials. Also, there is a need for awareness raising champagnes and training opportunities in the form of webinars, discussion sessions, success story showrooms, example case studies etc.

Germany

12 participants are of the opinion that awareness of sustainable building materials has not increased among those involved in construction. Twice this was justified by the fact that this is not an issue for the construction sites or that the construction sites have completely different worries than climate protection.

However, this question was also answered in the positive 9 times. A differentiation was made here between young and old colleagues: the younger ones are aware of the problem; the older ones are sometimes annoyed by the attempts to lecture them (we have always done it that way). Cement research was mentioned as an example of a positive development towards sustainable building materials: Cement can be partly replaced by other materials that cause no or only low greenhouse gas emissions. Cement production (capture and storage of CO2) is also moving in the right direction. Overall, however, the topic of sustainability is still in its infancy.

The proposals of the participants are very different. Some financial subsidies for sustainable building materials are mentioned (2x), better remuneration for sustainable building materials (3x), stricter standards and laws as well as higher penalties for non-compliance (3x), horror presentations of environmental hazards (similar to those on cigarette packs) as well as higher availability and choice of natural building materials (3x).

However, training and all kinds of formal and informal information were mentioned as the main argument (11x), especially in vocational training and further education, for example in foreman and master schools. Further training within the company was also addressed (large company). Unfortunately, three participants had no idea at all how awareness could be raised.

Italy

As the participants mentioned, in recent years the attention and awareness of the construction sector towards the environment and its protection have grown considerably.

With a growing global focus on environmental protection, companies are changing their business strategies towards more environmentally friendly approaches.

Above all, large companies are the most active in this direction. A lot of work still needs to be done on small and medium-sized companies which, moreover, are the most numerous in the construction sector.

Reducing the environmental effects on construction sites requires a collaborative effort.

According to all the participants raising awareness about the fight against climate change is essential, and the construction industry has an important role to play in this effort. Here are just some ideas that resulted from the discussion:

Education and Training: Educating and training professionals in the construction industry about sustainable building practices can help increase their awareness and understanding of the impact their work has on the environment. This could include offering training programs on sustainable building materials, energy-efficient design, and renewable energy systems.

Certification and Standards: Establishing certifications and standards for sustainable building practices can help promote their use in the industry. This could include certifications such as LEED (Leadership in Energy and Environmental Design) or BREEAM (Building Research Establishment Environmental Assessment Method).

Public Outreach: Engaging with the public through outreach campaigns can help raise awareness about the importance of sustainable building practices. This could include advertising campaigns, social media outreach, and community events.

Financial Incentives: Offering financial incentives for sustainable building practices can encourage more widespread adoption. This could include tax credits or subsidies for energy-efficient buildings or renewable energy systems.

Regulatory Support: Governments and regulatory bodies can support sustainable building practices by creating policies and regulations that encourage their adoption. This could include building codes that require certain levels of energy efficiency or renewable energy generation in new buildings.

Collaborative Partnerships: Collaboration between industry stakeholders, such as architects, engineers, contractors, and suppliers, can help promote sustainable building practices. This could include partnerships between these stakeholders to develop new sustainable building materials or design strategies.

3.6 Existing training provisions/capacity-building programs related to sustainable building materials (recycled / secondary raw materials) or relevant topics

Greece

The participants mentioned that the Technical Chamber of Greece has organized many seminars and training. These which referred are: Workshops regarding Building Information Modeling – BIM. Moreover, some participants refer that there is a Master's degree in "Materials Science and Technology" in the School of Chemical Engineering regarding conventional and advanced materials.

Romania

There are very few (almost non-existent) training programs in initial education, both at high school and at higher education level, dedicated to the field of energy efficiency and circular economy.

Educational programs began to appear in higher education, for example:

Master's program: Smart and sustainable constructions at the Faculty of Construction, Cadastre and Architecture Oradea

Master's program: Sustainable Concrete Constructions, Structural Engineering and Green Buildings at the Faculty of Construction Cluj-Napoca

Master's program: Urban and Regional Development, Energy Efficiency of Building Installations and Efficient Technologies for the Protection of the Urban Environment at UTC Bucharest

There are several professional training courses to increase the level of skills in the construction sector, Nzeb field, organized by INCERC Urban. There are no certified continuing professional training programs dedicated to this field.

Currently, in the revision process of the occupational standards, in the new standards on the basis of which the continuous training programs (qualification, specialization, improvement) are developed, competences regarding energy efficiency, environmental protection measures, digitalization, etc. are introduced.

Slovenia

The Construction Cluster of Slovenia[26] plays a role in training and disseminating these topics, which are funded by international development projects.

The media centre "Zelena Slovenija"[27]is also very strong and offers a range of sustainable or environmental topics related to construction.

[26] http://www.sgg.si/

[27] https://www.zelenaslovenija.si/

The Centre for Efficient Solutions of Slovenia[28] is also a network that successfully brings together providers of energy efficient solutions and concepts and helps with the introduction of the new GREEN STAR certification, which is a certificate for the introduction of sustainability aspects (ESG) and climate protection measures in a company. Once completed, the company's sub-sectors should better manage the business risks of the green transformation, increase efficiency and reduce costs, gain competitive advantage, improve access to capital, finance and insurance, and enhance reputation and credibility.

Republic of North Macedonia

The participants were not aware for any available training opportunities for sustainable materials in MK.

Germany

There was one disappointment in this discussion point: 19 out of 21 participants were not aware of any specific training courses on sustainable construction or sustainable building materials. Only two participants (large corporations) knew of corresponding training offers: In one case there are in-house trainings, in the other case regular webinars of the organization ProClima are booked.

Current training courses often deal with BIM, with topics related to building physics or with building law. In practice, seminars are also booked that include a certified qualification, e.g., as a building energy consultant. However, these courses are almost exclusively oriented towards assessing and reducing the energy demand of buildings and only indirectly around concrete sustainability.

Italy

IIPLE itself as a training provider includes courses that address the subject of CAM (Minimum Environmental Criteria) and the LEED (Leadership for Energy and Environmental Design), BREEAM (BRE Environmental Assessment Method) and ITACA protocols. More in details courses linked to sustainable building materials on the run are:

- Expert technician in energy transition
- Technician of design and management of the building process through the use of BIM and on the basis of the circular economy

Some trainers, who took part in the round table, took part in seminars organized by MAPEI on new sustainable building materials and products. Anyway, they confirmed that in general there

[28] https://cer-slo.si/

is no articulated training offer related to sustainable building materials (recycled / secondary raw materials).

3.7 Current level of awareness and ways to raise awareness for the fight against climate change in general and with a focus on the construction industry

Greece

The main ideas that participants mention for raising awareness and dealing with climate change were the policies, incentives, better information and education.

They refer that stricter and well-structured policies in order to reduce the impact of the construction sector will be helped. In parallel with the better information of citizens regarding the climate crisis and the construction sector. More incentives are crucial in order to follow more sustainable practices in all aspects of the construction sector. As they refer to incentives for including more sustainable building materials in construction and certifications about quality and durability will be helpful. Additionally, they refer that would be efficient to provide incentives for consumers – homeowners to boost them to choose more sustainable practices.

Education was mentioned as another important aspect, everyone knows about the causes of climate change but in Greece, there is confusion about the practical manner that we can deal with climate change. Training professionals regarding sustainable practices, sustainable materials and energy efficiency will help to have a more up-to-date workforce in the Construction Industry.

Romania

Based on the participants of the roundtable:

Material producers (against legislative constraints) have concerns about the recycling of materials (both through the recovery of waste from their own production process, but also from the end customers) and the re-introduction of waste into the production process. But we must mention that the weight and volume of this waste is very low compared to the actual amounts of resulting waste. There is a permanent preoccupation of material producers to renew technologies and bring new products to the market, which allow increasing the durability of materials and their circularity.

The main ways to raise awareness as mentioned from the participants:

By educating and informing the target audience about the circular economy, energy efficiency, etc. There are campaigns to promote and raise awareness of the circular economy concept and to adopt an environmentally friendly lifestyle (European Bauhaus) and there are also conferences, debates and research on sustainable solutions for energy and the environment/sustainable development in construction.

Slovenia

There is a need to start using social media platforms: social media has become an important factor in promoting climate change awareness. Regular posts about sustainable materials and buildings can create a ripple effect that gets people talking. Using tags and working with influencers can increase reach.

Host public events: Hosting an event such as a workshop or exhibition can raise awareness about the negative impact of climate change on the construction industry. It provides an opportunity to showcase innovative and sustainable building materials and methods.

Green labelling and transparent supply chains: Create a certification system for green buildings. Labelling buildings and products can help people make informed choices. It also creates competition within the industry, leading to a shift towards green practices.

Promotion of public transport and green travel: While this idea is indirectly related to the construction industry, it is still important. Transport contributes to greenhouse gas emissions that cause climate change. Promoting green travel helps to reduce the carbon footprint associated with building new roads and transport systems. Green transformation of VET center is also needed.

Some examples of sustainable materials and buildings are included:

Recycled brick: Manufacturers have been selling brick products containing a recycled content (between 2 and 30%) for some time. As recycled feedstocks, they add sawdust, which burns off during firing to form pores that improve thermal insulation, sedimentary sludge and slag.

Recycled concrete aggregate: the use of recycled aggregate made from crushed bricks with a certain percentage of waste raw material added as aggregate for concrete.

Hempcrete: this building material has natural insulating properties that reduce energy consumption and is carbon neutral. Hempcrete is made from the fibres of the hemp plant and mixed with lime and other natural materials.

Solar panels: They are a clean and renewable energy source used to power buildings. Installing solar panels lowers energy bills and reduces the carbon footprint.

Green roofs: Buildings with green roofs are covered with vegetation to reduce heat absorption. These roofs are suitable for biodiversity and can reduce carbon emissions while extending the life of the building.

In Slovenia, the construction industry must adopt sustainable practices in building and construction procedures. The government can impose strict regulations on companies to ensure compliance. In addition, incentives and tax breaks can be granted to companies that adopt sustainable construction practices. Investments in green technologies and innovations that promote the sustainability of buildings also create opportunities for start-ups in Slovenia.

Republic of North Macedonia

The utmost need for training on the topic for raising the awareness of the meaning, the benefits and the impact of sustainable construction materials is identified by respondents. There is a need for awareness raising champagnes and training opportunities in the form of webinars, discussion sessions, success story showrooms, example case studies etc.

Germany

12 participants are of the opinion that awareness of sustainable building materials has not increased among those involved in construction. Twice this was justified by the fact that this is not an issue for the construction sites or that the construction sites have completely different worries than climate protection. However, this question was also answered in the positive 9 times. A differentiation was made here between young and old colleagues: the younger ones are aware of the problem; the older ones are sometimes annoyed by the attempts to lecture them (we have always done it that way). Cement research was mentioned as an example of a positive development towards sustainable building materials: Cement can be partly replaced by other materials that cause no or only low greenhouse gas emissions. Cement production (capture and storage of CO2) is also moving in the right direction. Overall, however, the topic of sustainability is still in its infancy.

The proposals of the participants are very different. Some financial subsidies for sustainable building materials are mentioned (2x), better remuneration for sustainable building materials (3x), stricter standards and laws as well as higher penalties for non-compliance (3x), horror presentations of environmental hazards (similar to those on cigarette packs) as well as higher availability and choice of natural building materials (3x). However, training and all kinds of formal and informal information were mentioned as the main argument (11x), especially in vocational training and further education, for example in foreman and master schools. Further training within the company was also addressed (large company). Unfortunately, three participants had no idea at all how awareness could be raised.

Italy

As the participants mentioned, in recent years the attention and awareness of the construction sector towards the environment and its protection have grown considerably. With a growing global focus on environmental protection, companies are changing their business strategies towards more environmentally friendly approaches. Above all, large companies are the most active in this direction. A lot of work still needs to be done on small and medium-sized companies which, moreover, are the most numerous in the construction sector.

Reducing the environmental effects on construction sites requires a collaborative effort.

According to all the participants raising awareness about the fight against climate change is essential, and the construction industry has an important role to play in this effort. Here are just some ideas that resulted from the discussion:

Education and Training: Educating and training professionals in the construction industry about sustainable building practices can help increase their awareness and understanding of the impact their work has on the environment. This could include offering training programs on sustainable building materials, energy-efficient design, and renewable energy systems.

Certification and Standards: Establishing certifications and standards for sustainable building practices can help promote their use in the industry. This could include certifications such as LEED (Leadership in Energy and Environmental Design) or BREEAM (Building Research Establishment Environmental Assessment Method).

Public Outreach: Engaging with the public through outreach campaigns can help raise awareness about the importance of sustainable building practices. This could include advertising campaigns, social media outreach, and community events.

Financial Incentives: Offering financial incentives for sustainable building practices can encourage more widespread adoption. This could include tax credits or subsidies for energy-efficient buildings or renewable energy systems.

Regulatory Support: Governments and regulatory bodies can support sustainable building practices by creating policies and regulations that encourage their adoption. This could include building codes that require certain levels of energy efficiency or renewable energy generation in new buildings.

Collaborative Partnerships: Collaboration between industry stakeholders, such as architects, engineers, contractors, and suppliers, can help promote sustainable building practices. This could include partnerships between these stakeholders to develop new sustainable building materials or design strategies.

3.7 Main challenges when designing a training curriculum for building professionals

Greece

According to their experience, participants mentioned that the main challenges in designing a training curriculum for building professionals are: the curriculum to be up to date in the field and follow the current needs of the sector, include technical information, after the imposing of the COVID-19 pandemic is crucial to give the opportunity for synchronous and asynchronous training. Also, self-paced learning is considered by the participants as a really significant challenge and to be included practical applications and examples of best practices regarding the topic and not only the theory, in order to training be more specific and follow the needs of the industry sector. Last but not least, focus on specific topics related to the target audience.

Romania

There are very few (almost non-existent) training programs in initial education, both at high school and at higher education level, dedicated to the field of energy efficiency and circular economy so there is no knowledge regarding the design of this program in this topic.

Other issues are:

Funding and Affordability: Cost considerations can be a significant challenge when adopting sustainable building practices.

Cultural and Contextual Factors: Romania has its own unique cultural and contextual factors that may influence the adoption of sustainable building practices. The curriculum should consider these factors and provide case studies, examples, and solutions.

Slovenia

A general list of challenges that may be encountered when designing a curriculum for building professionals with a focus on sustainable building materials and buildings are: Keeping up with changing trends and technologies (including technical information) The world of sustainable building materials and buildings is constantly evolving, with new technologies emerging frequently. To be relevant and useful, curricula need to be updated regularly. Addressing knowledge gaps: Many building professionals may not have a comprehensive understanding of sustainable building materials and practices. Therefore, the curriculum needs to be designed to fill the knowledge gaps and provide practical skills.
Cost constraints: Sustainable building materials and practices tend to be more expensive than conventional techniques. The curriculum must address this challenge by teaching cost-effective techniques.
Adaptation to regional differences: Sustainable building materials and practices differ according to geographical location and climate. The curriculum must adequately address these differences.
Inadequate infrastructure: Sometimes the necessary infrastructure is not available or inadequate in certain regions, limiting access to the sustainable materials needed. This challenge needs to be addressed by teaching alternative solutions that are cost effective and can be sourced locally.

Republic of North Macedonia

It needs to be easy to follow, time adjustable, offered through interactive digital platforms for training and education to ease self-guided training progress, to be short enough to ensure the adjustment of time of the employed learners, to be available in different learning environments, depending on the target group (mobile apps, LMS, showrooms, gamified microlearning pieces, media production toward awareness etc.).

Germany

Aspects on different levels were mentioned and discussed. The two biggest obstacles in developing and designing learning opportunities are the expected costs (8x) and the time available (5x; staff absence is a real obstacle for companies to deal with trainings). Lack of motivation or too little interest were also mentioned. The difficulty of acquiring enough participants for these seminars was also seen. Precisely adapted methodology and didactics are crucial for success. If (almost) only theoretical knowledge and moralizing advice is imparted, no

change in awareness can be expected among the participants (they are multipliers for the companies). This is especially true for those involved in construction from the age of about 40. The participants agreed that training on sustainability must be very practical and varied in terms of didactics and methods (geared to the respective target group).

Italy

According to their experience designing a training curriculum for building professionals can present a number of challenges, such as: Keeping up with technological advancements: The building industry is constantly evolving, with new materials, technologies, and methods being developed all the time. It can be challenging to keep up with these changes and ensure that training programs are up-to-date and relevant.

Meeting diverse learning needs: Building professionals come from a wide range of backgrounds and have varying levels of knowledge and experience. It can be challenging to create a training curriculum that meets the diverse learning needs of this group.

Balancing theory and practice: Building professionals need to have a solid understanding of theoretical concepts, but they also need practical skills to be successful on the job. It can be challenging to strike the right balance between theory and practice in a training curriculum.

Addressing safety concerns: Building professionals work in a high-risk environment and need to be trained to work safely. Safety training needs to be incorporated into the training curriculum, but it can be challenging to make it engaging and effective.

Keeping the curriculum relevant: The building industry is subject to changes in regulations and standards, and it can be challenging to keep the training curriculum relevant and up-to-date in the face of these changes.

Ensuring consistency: When training large numbers of building professionals, it is important to ensure that the training is consistent across all participants. This can be challenging when dealing with different trainers and training locations.

Assessing learning outcomes: Finally, it can be challenging to assess the effectiveness of the training curriculum and ensure that participants have gained the knowledge and skills they need to be successful on the job. Proper assessments and evaluations need to be built into the curriculum to address this challenge.

3.9 Main challenges when delivering a training curriculum for building professionals

Greece

From their point of view, the main challenges are: the cost and the time of this training, if the training is not affordable and time demanding will be difficult to attend for building professionals, the knowledge gaps which the training covers, because many training curricula are theoretical and they do not cover practical knowledge and meet the needs of the market be too conventional,

as the building experts have various foundations, and the training can be general and not have explicit substance and lack of coherence, as building professionals have many different backgrounds seem difficult a training program to be well-structure and cover all these backgrounds.

Slovenia

Lack of awareness and knowledge: Building professionals in Slovenia may have limited knowledge and awareness of sustainable building practices and materials, which may affect their understanding and ability to implement sustainable solutions.
Availability of sustainable materials: The availability of sustainable materials in Slovenia may be limited, making it difficult to apply these practices and materials in construction projects.
Costs: Sustainable construction materials and practices sometimes involve higher costs. This can make it difficult for construction professionals to justify the additional expenditure, especially if they are not familiar with sustainable solutions and their long-term benefits.
Resistance to change: Construction professionals in Slovenia may be resistant to change and find it difficult to adopt new technologies and practices and to deviate from traditional construction methods.
Regulatory environment: The regulatory environment in Slovenia may not provide incentives or support for the shift to sustainable construction practices, which may limit progress in this area.
Lack of certification and accreditation: There may be few or no certification programs or accreditations for professionals involved in sustainable construction practices in Slovenia. This may affect the quality of training and the application of these practices in construction projects.

Overall, providing a sustainable building materials/buildings curriculum for construction professionals in Slovenia requires careful consideration of the local context, the needs of the audience and the challenges associated with sustainable building practices.

Republic of North Macedonia

The main challenges that referred are: lack of time, unfamiliar with rigid learning environment, lack of interest, lack of visible advantages that the learning process is providing (professional development, higher employability, carrier development, certification etc.)

Germany

Many participants saw the cost problem or the time required in the foreground. Above all, the cost-benefit ratio must be right for the company; only then can acceptance and motivation for seminars be awakened. In any case, the training must take place during regular working hours. One participant was of the opinion that it is not expedient to offer training on sustainability at this point in time; first of all, the awareness for it has to increase even more (the participant experiences rejection if he raises the topic on the construction site). Another aspect deals with the availability of "real" experts, i.e. not only with political intentions, but with profound technical

and expert knowledge. The development of an official certificate for sustainable construction was also suggested (unique selling point for the company). All participants agreed once again that the curriculum must be practical and not only theoretical. The choice and preparation of the accompanying training media is very important.

Extensive written documents are not very suitable; interactive presentations and YouTube videos as well as a learning platform where participants can exchange information and share their experiences would be more effective.

Italy

In line with what previously stated, participants confirmed that there are several challenges when delivering a training curriculum for building professionals, some of which include: Keeping up with evolving industry standards: Building codes, safety regulations, and industry standards are constantly evolving. It can be a challenge to stay up-to-date with these changes and incorporate them into training materials.

Catering to different skill levels: Building professionals come from different educational backgrounds and levels of experience. It can be challenging to design a training curriculum that caters to both novice and experienced professionals. Balancing theoretical and practical learning: Building professionals require both theoretical and practical knowledge to excel in their roles. It can be challenging to balance these two types of learning and provide hands-on training opportunities.

Meeting the needs of diverse learners: Building professionals come from diverse backgrounds and have different learning styles. Training curriculums need to cater to these different learning styles and incorporate a variety of teaching methods to engage all learners.

Limited resources: Developing and delivering a comprehensive training curriculum can require significant resources, including time, money, and staff. It can be challenging to ensure that all necessary resources are available to deliver effective training.

Keeping up with technological advancements: The building industry is rapidly evolving with new technologies being introduced constantly. It can be a challenge to keep up with these advancements and incorporate them into a specific training curriculum.

3.10 Key conclusions reached on transnational level

Based on the 6 national and 1 international roundtable some key conclusions are:

- There are very few (almost non-existent) training programs in initial education, both at high school and at higher education level, dedicated to the field of energy efficiency and circular economy.

- There are no continuing professional training programs dedicated to this field.

- Currently, in the revision process of the occupational standards, in the new standards on the basis of which the continuous training programs (qualification, specialization, improvement) are developed, competences regarding energy efficiency, environmental protection measures, digitalization, etc. are introduced.

Based on the information provided, some key conclusions regarding the challenges, barriers, and familiarity with national and EU strategies related to sustainable building materials:

- Technical Barriers: Lack of knowledge and expertise in sustainable building practices is a common challenge in all the mentioned countries. More education and training are needed to promote the adoption of sustainable construction practices among architects, engineers, and builders.

- Legal Barriers: Greece, Romania, and Slovenia face challenges with their legislation. The implementation of EU regulations into national law is problematic, and there is a need for more supportive regulations to promote sustainable building. Inconsistencies and outdated building codes and regulations also hinder the use of sustainable materials.

- Institutional Challenges: Lack of policy and regulatory coherence is a significant barrier in Slovenia and Greece. There is a need for better coordination and awareness at the local and regional level. In Romania, the lack of specialists in sustainable construction and energy efficiency is a challenge.
- Financial Challenges: Sustainable construction and the use of sustainable materials are often more expensive than conventional practices. The additional costs are a deterrent for customers, and the lack of financing options for sustainable projects poses a challenge.

- Awareness and Familiarity with Strategies: Overall, participants in the mentioned countries have some level of familiarity with national and EU strategies related to sustainable building materials and energy efficiency. The Energy Performance of Buildings Directive (EPBD) and the Nearly Zero Energy Buildings (nZEB) standard are commonly known. However, there are variations in the level of awareness and implementation across different stakeholders.

Key conclusions for the challenges in designing and delivering a training curriculum for building professionals:

- The curriculum should be up to date, addressing current needs and trends in the building industry.
- Technical information and practical applications should be included to enhance the relevance and specificity of the training.
- Balancing theoretical and practical learning
- Collaboration with industry stakeholders is crucial to align the curriculum with industry needs and practices.

- Time availability and cost can be significant challenges in delivering training programs. Ensuring affordability and providing flexible training options, such as self-paced or asynchronous learning, can help overcome these challenges.

4. Transnational recommendations for the inventory of sustainable building materials

Respecting the opinions reflected and the input shared by all participants involved in the national and international roundtables, as well as the feedback collected through the desk research activities, the recommendations that should be strongly considered upon the training design phase of the sustainable building materials training program are summarized as follows.

These recommendations aim to increase awareness, enforce sustainability through legislation, and improve the understanding and accessibility of sustainable construction materials. Here are the key recommendations:

1. Enforcing Sustainability through Legislation and Standardization

All decision-makers should agree on the importance of enforcing sustainability through stricter standardization and approval procedures if necessary.

Implement laws and regulations that support the use of sustainable building materials and encourage their widespread adoption.

2. Promoting Awareness and Distinction of Sustainable Materials

Conduct educational campaigns and promotional events to raise awareness about sustainable materials and differentiate them from conventional ones.

Clearly communicate the benefits of using sustainable construction materials to users, highlighting their positive impact on the environment and long-term benefits.

3. Carbon Footprint Calculation Methodology:

Increase awareness and knowledge about the carbon footprint calculation methodology in the construction industry.

Standardize and widely apply the carbon footprint calculation methodology throughout the manufacturing and use cycle of construction materials.

4. Promoting the Use of Recyclable Materials

Familiarize buyers and beneficiaries of construction materials with the use of recyclable materials that offer the same or improved quality characteristics compared to conventional materials.

Build confidence in the quality and performance of recyclable materials to encourage their adoption.

5. Encouraging Waste Recovery and Reuse

Increase awareness about the importance of recovering and reusing waste generated by construction activities.

Develop infrastructure for the collection and recycling of construction waste, reducing costs and promoting responsible behaviour.

6. **Dissemination of Legislative Provisions and Transposition**

Widely disseminate European Union legislative provisions related to constructions and construction materials.

Accelerate the transposition of Community legislation into national legislation to ensure timely implementation of sustainable construction practices.

7. **Coordination and Transition Process**

Foster transparency and accelerate the transition from conventional construction materials to sustainable ones.

Ensure better coordination of actions and policies aligned with the objectives of the European Green Deal and European Climate Pact.

8. **Correlation with Technical Regulations and Standards**

Increase the degree of correlation between the current legislative framework and technical regulations regarding construction materials.

Ensure that sustainable construction materials comply with existing technical standards and regulations.

9. **Enhancing Education and Training**

Strengthen vocational and educational training in the construction sector to provide a highly qualified workforce with knowledge of sustainability principles, circular economy, and energy-efficient construction materials.

By implementing these transnational recommendations, decision-makers and stakeholders can effectively shift towards sustainable building materials, thereby promoting the protection of environment, the reduction of resource consumption, and lower greenhouse gas emissions within the construction industry.

5. Transnational recommendations that should be linked with the training design

Respecting the opinions reflected and the input shared by all participants involved in the national and international roundtables, as well as the feedback collected through the desk research activities, the recommendations that should be strongly considered upon the training design phase of the sustainable building materials training program are summarized as follows.

An effective training program for sustainable building materials:

- Integrate sustainability principles into the entire building process. This includes training on sustainable design principles, energy-efficient systems, waste reduction strategies, and life cycle assessments.
- Hands-on training opportunities are essential for developing the skills and knowledge needed to implement sustainable building practices. Site visits, seminars, and apprenticeships provide practical experiences that reinforce theoretical learning and enable participants to see sustainable materials and practices in action.
- Promoting collaboration and knowledge sharing among relevant stakeholders is crucial for fostering a more sustainable construction industry.
- Technology and online learning platforms can increase access to education programs and provide flexible learning options. Online courses and webinars can be combined with traditional face-to-face training to cater to different learning styles and preferences.
- Measure the impact of training programs to ensure their effectiveness. Regular evaluation allows for the identification of areas for improvement and ensures that the training meets the needs of participants and the construction industry as a whole.
- Expanding the training curriculum to cover topics such as selective demolition, appropriate sorting, recycling of inert waste, secondary raw materials for building and construction, urban extraction and recycling, and the role of Green Public Procurement can further enhance the knowledge and skills of participants. These topics address specific challenges and opportunities in sustainable construction.
- Encouraging participation, the training program should be designed with low additional time and organizational burdens for participants. Financial support from associations or policies can help keep the costs of the training program low. The didactic and methodological concepts should be tailored to the target audience to ensure effective knowledge transfer.
- To provide a fundamental understanding, the training program should identify and describe the most relevant sustainable materials, their production processes, and how they differ from conventional building materials. International case studies and best practices can be included to illustrate practical applications.
- Addressing local issues, practices, and the current status of sustainable building materials will make the training program more relevant. Participants should learn ways to promote sustainable materials over conventional ones, taking into account the specific context and challenges of their local construction industry.
- Technical information on sustainable building materials, particularly recycled and secondary raw materials, should be provided to enable participants to use these materials effectively. This information should cover cost, availability, effectiveness, and durability, enabling participants to make informed decisions.
- Informing participants about laws and regulations related to sustainable building practices and materials is crucial. This knowledge will help participants understand the obligations, needs, and benefits of sustainable construction. Focus on specific topics that are relevant to the target audience, going beyond general information, will enhance the practicality and applicability of the training program.
- Hands-on experience and practical implementation should be emphasized in the training program. Building professionals need to gain practical knowledge of using sustainable building materials through activities and exercises that simulate real-world scenarios.

By adopting a holistic approach that addresses the current status of sustainable building materials, best practices, case studies, technical information, and barriers, a comprehensive and efficient training program can be developed to meet the upskilling needs of the construction sector.

References

1. 2020 Voluntary National Review – North Macedonia. Sustainable Development Goals Knowledge Platform, United Nations. https://sustainabledevelopment.un.org/memberstates/macedonia
2. A Green Deal Industrial Plan for the Net-Zero Age (February 2023). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. https://commission.europa.eu/system/files/2023-02/COM_2023_62_2_EN_ACT_A%20Green%20Deal%20Industrial%20Plan%20for%20the%20Net-Zero%20Age.pdf
3. Antoniou, F.; Demertzidou, F.; Mentzelou, P.; Konstantinidis, D. (2022). Energy upgrading of buildings in Greece with eco-materials. An investigation of public awareness. IOP Conf. Ser.: Earth Environ. Sci. 1123 012033. DOI:10.1088/1755-1315/1123/1/012033. https://iopscience.iop.org/article/10.1088/1755-1315/1123/1/012033/meta
4. Architecture2030. https://architecture2030.org/buildings_problem_why/
5. Architecture2030. https://architecture2030.org/new-buildings-embodied/
6. https://www.baunetzwissen.de/glossar/g/gebaeudeenergiegesetz-geg-8143068
7. Baustoffkenntnis, 18. Aufl., S. 18.22 f; Bundesanzeiger Verlag
8. Building Research Establishment Environmental Assessment Method (BREEAM) (1990). Bre Group, https://bregroup.com/products/breeam/
9. Building Rules List, A, Building Rules List B and List C; Edition 2015/2; Publisher: German Institute for Building Technology (DIBT); Berlin
10. BUNG Erasmus+ project: https://www.bung-project.eu/
11. CasaClima (2002). Agency for Energy South Tyrol – CasaClima, https://www.agenziacasaclima.it/en/welcome-1.html
12. Commission Decision establishing the European Union Ecolabelling Board and its rules of procedure, from < https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0709>
13. Construction Projects in Highly Urbanized Cities—A Case Study of Hong Kong. Buildings 2021, 11, 214, https://doi.org/10.3390/ buildings11050214
14. Crawford RH (2014). Post-occupancy life cycle energy assessment of a residential building in Australia. Architectural Science Review 57(2):114–124, from < Post-occupancy life cycle energy assessment of a residential building in Australia: Architectural Science Review: Vol 57, No 2 (tandfonline.com)>
15. Crawford RH (2019). Embodied energy of common construction assemblies (Version 1.0). The University of Melbourne, Melbourne, form < Embodied energy of common construction assemblies (figshare.com)

16. Crawford RH, Stephan A and Prideaux F (2019). EPiC database (Version 1.0). The University of Melbourne, Melbourne, from < Environmental Performance in Construction (EPiC) Database: a database of embodied environmental flow coefficients | Semantic Scholar>
17. Design and build with BIM (Building Information Modelling). Autodesk Construction Cloud. https://www.autodesk.com/industry/aec/bim
18. Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0075.01.ENG
19. Energy Efficiency Directive 2012/27/EU. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1399375464230&uri=CELEX:32012L0027
20. Energy Performance of Buildings Directive 2010/31/EU (EPBD). https://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=FZMjThLLzfxmmMCQGp2Y1s2d3TjwtD8QS3pqdkhXZbwqGwlgY9KN!2064651424?uri=CELEX:32010L0031
21. Energy Performance of Buildings Directive 2018/844/EU (EPBD). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018L0844
22. Energy Star Training Centre. https://www.energystar.gov/partner_resources/energy_star_training_center
23. European Climate Pact (December 2020). European Commission. https://op.europa.eu/en/publication-detail/-/publication/f2587cfe-643d-11eb-aeb5-01aa75ed71a1/language-en/format-PDF/source-189797220
24. European Union Ecolabelling Board and its rules of procedure (June 2020), from < https://circabc.europa.eu/ui/group/6e9b7f79-da96-4a53-956f-e8f62c9d7fed/library/6e484c8f-83e2-4ffc-b4d0-5f083f0ece21/details?download=true>
25. Evaluation of the Implementation of the EU Ecolabel Regulation - Synthesis Report, from < https://environment.ec.europa.eu/document/053cc47b-c1c9-4590-af61-fe37888ae75f_en>
26. Federal funding for efficient buildings (Bundesförderung für effiziente Gebäude - BEG). Federal Ministry for Economic Affairs and Climate Action. https://www.bmwk.de/Redaktion/DE/Gesetze/Energie/EnEV.html
27. Federal Office for Economic Affairs and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle – BAFA). https://www.bafa.de/DE/Energie/Effiziente_Gebaeude/effiziente_gebaeude_node.html
28. Fetting, C. (2020). The European Green Deal. ESDN Report, December 2020, ESDN Office, Vienna. https://www.esdn.eu/fileadmin/ESDN_Reports/ESDN_Report_2_2020.pdf
29. Ghid privind implementarea măsurilor de creștere a performanței energetice aplicabile clădirilor noi, în etapele de proiectare, execuție și recepție, exploatare și urmărire a comportării în timp pentru îndeplinirea cerințelor nZEB, Indicativ RTC 4 – 2022. Anexa la O.M.D.L.P.A. nr.2818/02.11.2022. https://www.oar-bucuresti.ro/anunturi/2022/12/05/a/text_ghid.pdf

30. Green Building Professional Certificate (GBPC), Green Building Certification Institute (GBCI). World Green Building Council. WorldGBC. https://worldgbc.org/
31. Green Globes Professional (GGP) Certification. Green Building Initiative https://thegbi.org/why-green-globes/
32. http://www.batiment-energiecarbone.fr/en/obtaining-the-certification-label-a25.html
33. https://8billiontrees.com/carbon-offsets-credits/carbon-footprint-of-building-materials/#ref-3
34. https://www.bmuv.de/gesetz/kreislaufwirtschaftsgesetz
35. https://bregroup.com/products/breeam/
36. https://constructionblueprint.eu/de/onlinekurse/
37. https://www.dgnb.de/en/certification/important-facts-about-dgnb-certification/about-the-dgnb-system
38. https://www.ecolabelindex.com/ecolabels/?st=category,building_products
39. https://www.ibau.de
40. https://www.kfw.de/kfw.de.html
41. https://www.sachsen-anhalt-energie.de/de/modellhaus-baustoffe-bauteile.html
42. https://www.usgbc.org/
43. https://www.zerowastedesign.org/02-building-design/fa-construction-demolition-waste-best-practice-strategies/
44. Implementation of Article 11 under the EU Ecolabel Regulation- Final Report, from, https://environment.ec.europa.eu/document/6acdb550-074c-40ee-9040-eaf99930f001_en
45. Integrated National Energy and Climate Plan of The Republic of Slovenia (27 February 2020). Guvernul Republicii Slovenia. https://energy.ec.europa.eu/system/files/2020-06/si_final_necp_main_en_0.pdf
46. ISPRA, Rapporto Rifiuti Speciali 2021 e Rapporto Rifiuti Urbani 2021
47. Le Bourhis, E., 2014. *Glass: mechanics and technology*. John Wiley & Sons. https://www.perlego.com/book/2768913/glass-mechanics-and-technology-pdf
48. LEED Certification, US Green Building Council, https://www.usgbc.org/leed
49. Legea nr. 159 din 15 mai 2013 pentru modificarea şi completarea Legii nr. 372/2005 privind performanţa energetică a clădirilor. Parlamentul României. MONITORUL OFICIAL nr. 283 din 20 mai 2013. https://legislatie.just.ro/Public/DetaliiDocumentAfis/148043
50. Materials CAN Carbon Action Network. www.materialsCAN.org
51. National Energy and Climate plan (December 2019). Hellenic Republic, Ministry of the Environment and Energy. https://energy.ec.europa.eu/system/files/2020-03/el_final_necp_main_en_0.pdf
52. OECD, Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences (Paris, 2019), https://doi.org/https://doi.org/10.1787/9789264307452-en
53. Passive House Certification Criteria, International Passive House Association, https://passivehouse-international.org/index.php?page_id=150

54. Petkar, Sanket Suresh, Environmental impact of Construction Materials and Practices, DOI: 10.13140/RG.2.1.2581.0001, 2014
55. Piano d'Azione per l'Energia Sostenibile e il Clima (PAESC). Azzero CO_2. https://www.azzeroco2.it/soluzioni/paesc/
56. Planul Național de Acțiune pentru Eficiența Energetică (2017). Guvernul României. https://energie.gov.ro/wp-content/uploads/2018/02/HG-aprobare-PNAEE-4-site-ME-7feb2018-1.pdf
57. Programul Casa Verde Fotovoltaice (2019, 2021, 2022). Guvernul României, Ministerul Mediului. Administraţia Fondului pentru Mediu. https://www.afm.ro/sisteme_fotovoltaice.php
58. REFIT Report, from < https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2017%3A355%3AFIN>
59. Report of the World Commission on Environment and Development: Our Common Future (Brundtland Report) (1987). United Nations. https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html
60. Sönmez, N. and Kalfa, S.M., 2023. Investigation of Construction and Demolition Wastes in the European Union Member States According to their Directives. Contemporary Journal of Economics and Finance, 1(2), pp.7-26.
61. Strategia națională pentru dezvoltarea durabilă a României 2030. Adoptată prin HG nr. 877/9 noiembrie 2018. Monitorul Oficial nr. 985/21 noiembrie 2018. https://dezvoltaredurabila.gov.ro/strategia-nationala-pentru-dezvoltarea-durabila-a-romaniei-2030-i
62. Strategia națională privind economia circulară (16 August 2022). Ministerul Mediului. http://www.mmediu.ro/app/webroot/uploads/files/Strategia%20Nationala%20privind%20Economia%20Circulara%20-%20var%20finala.pdf
63. Sustainable Building Advisor (SBA). The National Institute of Building Sciences (NIBS). https://www.nweei.org/professional-development/sba/all-pages.html
64. Sustainable Building Council Greece (SBC Greece), https://sbcgreece.org/en/homepage/
65. Tafesse, S., Girma, Y. E., & Dessalegn, E. (2022). Analysis of the socio-economic and environmental impacts of construction waste and management practices. Department of Construction Technology and Management, College of Engineering and Technology, Dilla University, Dilla, Ethiopia
66. The New European Bauhaus, https://new-european-bauhaus.europa.eu/index_en
67. The University of Melbourne (2019). Low energy building assembly selector, from. Low Energy Building Assembly Selector (unimelb.edu.au)
68. The Welding Institute (TWI), https://www.twi-global.com)
69. UNEP and IEA, "Global Status Report 2017: Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector," 2017.

70. Weterings, T. and Tustin, J. (2017). Energy consumption benchmarks: electricity and gas for residential customers, ACIL Allen Consulting, Melbourne, Victoria, from < EE-Download-Impact-Datasheet-Energy-Consumption-Benchmarks.pdf (rockefellerfoundation.org)>
71. www.Carbonleadershipforum.Org
72. Yu, A.T.W.; Wong, I.;Wu, Z.; Poon, C.-S. Strategies for effective Waste Reduction and Management of Building