BUILD UP Skills – Austria
Analysis on the National Status Quo

Education and Training for Achieving the Energy and Climate Targets in the Austrian Building Sector

Report

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0 Executive Summary

The present status quo analysis contains the necessary basics relevant for the development of a national education and training roadmap to achieve the energy and climate targets in the building sector in Austria. They refer to information about the current state of the energy policy and legal framework and the status quo of the Austrian building sector, the existing framework conditions in education and training as well as the results of an evaluation of the implementation of the national roadmap until 2020. It also examines skills and qualification gaps as well as possible barriers and opportunities related to the qualification of professionals in the building sector, which could support or hinder the achievement of energy and climate targets in this field. A range of methods was used to prepare the report, including literature and desktop research, internal working meetings, interviews and workshops with experts, practitioners and stakeholders from the fields of construction and property, education and training, as well as labor market research. For quality assurance, interim results were continually reviewed.

The existing framework conditions presented in the status quo analysis as well as the identified strengths, weaknesses, opportunities and threats form the basis for the development of targeted strategies and measures in the field of education and training to achieve the energy and climate targets in the Austrian building sector.

Professionals in the Austrian building sector

As part of the status quo analysis, more than 70 occupational profiles that are directly related to the planning, construction or operation of buildings and are classified as relevant for achieving the energy and climate targets in the building sector were identified in Austria. The building sector, and in particular the "construction" sector, is dominated by small companies (around half of the employees here work in companies with fewer than 50 employees). In 2022, about 324,000 non-self-employed persons were working in the construction sector. Most of them are assigned to the sectors of building construction, electrical installation, gas, water, heating and ventilation and air conditioning installation, roofing and carpentry, road construction, and painting and glazing. In terms of educational qualifications, the construction sector is dominated by apprenticeship, completed by 57% of employees. Sixteen percent have completed compulsory education. 14% have a secondary school diploma. Five percent have a tertiary degree. Women are strongly underrepresented in the construction industry, with only 13% of employees being female.

In 2022, around 324,000 employees were working in the construction sector in Austria. According to the International Standard Classification of Occupations (ISCO-08), these can be categorised into the following occupational groups[1]:

Employees in the construction sector (ÖNACE 2008) in Austria in 2022 by occupational group (ISCO-08)	
Engineering Professionals <214>	8.900
Physical and Engineering Science Technicians <311>	27.900
Construction Supervisors <312>	19.100
Building Frame and Related Trades Workers <711>	60.700
Building Finishers and Related Trades Workers <712>	58.800
Painters, Building Structure Cleaners and Related Trades Workers <713>	13.200
Blacksmiths, Toolmakers and Related Trades Workers <722>	4.000
Electrical Equipment Installers and Repairers <741>	30.100
Wood Treaters, Cabinet-makers and Related Trades Workers <752>	5.200
Mobile Plant Operators <834>	9.100
Construction Labourers <931>	17.300

Source: Microcensus Labour Force Survey annual data. Retrieved from STATcube - Statistical database of Statistics Austria on 01.02.2024, economic activity ÖNACE 2008

Energy consumption and greenhouse gas emissions

In Austria, the building sector is responsible for almost one third of final energy consumption and for about 17% of the greenhouse gas emissions, whereby "embodied carbon" emissions from construction and maintenance as well as from the dismantling of buildings are not included. This makes it the sector with the second highest emissions after transport. Private households cause a high share of energy consumption in the building sector. More than one

[1] A precise translation of Austrian professions for the specified English terms (Architects, Designers, Civil engineers, Structural engineers, Electrical engineers, Mechanical engineers, Building services & HVAC engineers, Building site inspectors, Building surveyors, Building Managers, Energy Assessors, Other(s) as needed) is not possible due to the country-specific professional system. Therefore, the internationally recognised standard ISCO-08 was used here as a reference framework for occupational classification and translation. Due to the limited sample size of the microcensus, for some occupational groups an extrapolation is not possible (see also Table 4 in Chapter 4.3.2 Employment statistics).

third of Austrian households currently still heat primarily with fossil fuels, using mainly oil and gas heating systems. Thanks to efforts to improve the energy efficiency of buildings, to increase renovation activities, and to switch the energy supply from fossil to renewable sources, emissions in the building sector in 2022 have been 36% lower than in 1990. However, increasing residential floor space per capita, growing comfort needs and the associated rise in heating energy consumption are counteracting the successes achieved in other areas – such as the improvement of building envelopes and the use of modern heating technology. This has led to stabilization in recent years, but not to the targeted further reduction of greenhouse gas emissions.

- **In 2021, the building sector in Austria (without "embodied carbon") accounted for around 17% of total greenhouse gas emissions.**
- **A high proportion of energy consumption in the building sector is caused by private households; in 2021, this accounted for 323 petajoules or roughly 30% of the total Austrian final energy consumption.**
- **More than a third of Austrian households still primarily use fossil fuels (mainly oil and gas) for heating.**

Austrian energy and climate targets

Austria intends to achieve climate neutrality by 2040. The legal framework is provided by the Austrian Climate Protection Act (Klimaschutzgesetz – KSG), which was passed in 2011 and amended in 2017. The government program 2020–2024 provides for the revision of the Austrian Climate Protection Act in order to set the path towards climate neutrality by 2040 and to implement the tightened targets at EU level on a national level. Currently, a corresponding bill is still being drafted (as of February 2024). The Austrian National Energy and Climate Plan (Nationaler Energie- und Klimaplan – NEKP, currently under revision) sees great potential for reducing greenhouse gas emissions in the building sector through thermal refurbishment, the switch to renewable energy sources and highly efficient district heating in existing buildings, as well as the omission of fossil fuels in new construction. The Austrian Renewable Heat Act (Erneuerbaren-Wärme-Gesetz, EWG), which came into force in February 2024, aims to ban the installation of heat supply systems based on fossil fuels for heating and hot water in new buildings. The rapid and strong increase in the energy renovation rate, in particular the increase in the rate of deep renovation, plays a central role in achieving the energy and climate targets.

- **Austria aims to achieve climate neutrality by 2040. The building sector holds great potential for reducing greenhouse gas emissions.**
- **Increasing the rate of energy renovation of buildings as well as switching to renewable energy sources and high-efficiency district heating in existing buildings will play a key role in achieving energy and climate targets.**

- **From 2024, it will no longer be permitted to install heating systems based on fossil fuels in new buildings.**

Skilled labour and qualification needs

In the construction industry, as in other sectors, there is currently a shortage of skilled workers in Austria. Among the occupational groups particularly affected are craft professions in general, but also professions in the field of electronics/electrical engineering as well as installation and building services engineering. At the end of October 2022, 8,595 immediately available jobs in construction were registered with the Public Employment Service (Arbeitsmarktservice – AMS) throughout Austria. A shortage of skilled workers has been identified, for example, in the design and installation of photovoltaic systems. However, it is to be expected that the already existing shortage of skilled workers will be massively exacerbated by an increase in the renovation rate to the extent required by energy policy. Depending on market developments in the construction of new buildings and in other segments of the construction industry, this could lead to shifts in the economic activity of construction companies. For this reason, there is a particularly high need for qualifications in this area, both in initial and continuing training at all national qualifications framework (NQF) levels. So far, the skills needed for the deep renovation of buildings and the decarbonization of the energy supply in existing buildings are only partially anchored in most education sectors.

Depending on the estimation or modelling approach and the underlying development scenarios, different studies estimate a labour requirement of up to 22,000 additional employees in the construction sector for the necessary thermal refurbishment and the switch from fossil fuels to renewable energy sources in existing buildings until 2040. In the case of thermal refurbishment, with over 50% the highest labour requirement is estimated for persons with a minimum qualification of skilled workers (NQF4 and higher), while around a third is accounted for by semi-skilled workers and the rest by unskilled workers (<NQF4).

The status quo analysis of the education sector shows that the existing education and training programmes in Austria related to the building sector are wide-ranging and very diverse. There is a large number of formal qualifications that are either directly or indirectly related to the building sector. Vocational education and trainings (NQF4 and NQF5) provide a broad foundation that enables graduates to pursue a wide range of professions and specialisations. In the formal qualification system, there are not only programmes for young people, but also educational programmes for adults that build on existing qualifications as further qualification measures (NQF5).

There are a large number of actors and providers in the field of continuing professional development, as well as a wide range of continuing education programmes in different formats that address issues related to achieving energy and climate targets in the buildings sector. Furthermore, there are a number of different academic continuing education programmes (NQF 6 and higher) related to the energy and buildings sector.

Compared to other sectors, the participation in in-service vocational education and training in the building sector is low. Some target groups that play an important role in achieving the energy and climate targets in the building sector are currently not being addressed or reached sufficiently with appropriate programmes to impart relevant skills. Women are under-represented in almost all areas of education and training related to the building sector.

Teaching content to provide skills for achieving the energy and climate targets in the building sector is embedded to varying degrees in different education sectors and with reference to different subject areas.

A particularly high need for qualification is seen in the area of thermal refurbishment, both in initial and continuing education and training for all NQF levels. However, the transfer of skills for the implementation of thermal renovation of buildings (including deep renovation) and the decarbonisation of the energy supply in existing buildings has so far only been partially anchored in most education sectors. Skills and competences related to increasing circularity and resource efficiency are also not yet sufficiently covered.

The transfer of skills for increasing energy efficiency and the use of renewable energies in the building sector – as well as for considering and optimizing greenhouse gas emissions through the assessment of global warming potential – is already well embedded in curricula across all education sectors and covered by existing continuing education programs. Yet, there is potential for improvement through a stronger focus on the building life cycle and the implementation of life cycle approaches.

Measures to increased participation in education and training, the addressing of specific target groups, and the consistent integration and ongoing quality assurance of relevant teaching and training content in existing education and training programmes were identified as important starting points with regard to qualified professionals for achieving the energy and climate goals in the Austrian building sector.

- **There is currently a shortage of skilled labour in the Austrian construction sector. The occupational groups particularly affected include skilled trades in general, but also professions in the fields of electronics and electrical engineering, as well as installation and building services engineering.**
- **Depending on the estimation or modelling approach, recent studies estimate the need for up to 22,000 additional employees, to carry out the necessary thermal renovation and conversion from fossil fuels to renewable energy sources in the building stock.**
- **The status quo analysis of the education sector shows a wide range of formal qualifications (NQF4 and higher) that are either directly or indirectly related to the building sector. In addition, there is a wide range of continuing professional development programmes that address topics related to achieving the energy and climate targets in the building sector.**
- **The transfer of skills for increasing energy efficiency and the use of renewable energies in the building sector is already well embedded in syllabuses and curricula across all education sectors or covered by existing continuing education programmes.**

- **The transfer of skills for carrying out thermal building renovations (including deep renovation) and decarbonising the energy supply in existing buildings is yet only partially covered in most education sectors. A particularly high need for qualification is identified in this field for all NQF levels in both initial and continuing education.**
- **Skills and competences related to increasing the circularity and resource efficiency of buildings are still not sufficiently represented across all NQF levels. Although skills for the consideration and optimisation of greenhouse gas emissions are already adressed in most curricula and syllabuses, there is potential for improvement through a stronger focus on the building life cycle.**
- **Important starting points related to qualified professionals for achieving the energy and climate targets in the building sector were identified in increasing the participation in education and training, the addressing of specific target groups, and the consistent integration and ongoing quality assurance of relevant teaching and training content in existing education and training programmes.**

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1 Introduction

A drastic reduction in greenhouse gas emissions is essential if Austria is to meet its ambitious climate targets by 2040. The building sector plays a central role in this as buildings account for around 40% of energy consumption and 36% of greenhouse gas emissions in the EU.

In Austria, private households are responsible for about 30% of final energy consumption. The size of usable floor space per capita, the quality of the building envelope and the type of heat generation are identified as the most important factors influencing energy consumption and greenhouse gas emissions. Against this background, planning and cross-trade cooperation in construction as well as the qualification of skilled workers are of particular importance. For this reason, the European Commission dedicated itself to the qualification of construction specialists as part of the "BUILD UP Skills" initiative as early as 2011. The intention behind this was to ensure an optimum level of training for skilled workers in the areas of building renovation and new construction by 2020. Following this initiative, a large number of national and Europe-wide projects were successfully carried out between 2013 and 2020.

The project "Reboot BUILD UP Skills Austria" (ReBUSk) picks up the topic of the necessary qualification in the building sector to ensure a climate-neutral future. Previously, the focus was on the necessary qualification of blue-collar professionals. In the "ReBUSk" project, the expanded focus was directed at all professional areas of education and training that are involved in the planning and realization of new buildings and renovations. The goal is to develop a national education and training roadmap for the building sector by 2030, which goes hand in hand with both the European climate protection goals by 2050 and the national climate protection goals by 2040. This new education and training roadmap is intended to ensure that all necessary skills and competences for climate-neutral construction are available in Austria by 2030.

To achieve this, a national qualification platform was created to discuss the qualification needs in Austria until 2030 and the future of the building sector. This platform is an important instrument as it brings together all relevant stakeholders and involves them in the project implementation. The ReBUSk qualification platform consists of members of educational institutions, chambers, guilds as well as political decision makers, project developers and housing associations.

In cooperation with this qualification platform, the present analysis of the national status quo of education and training in the building sector was developed, which should now serve as a basis to work out a common education and training roadmap for Austria until 2030.

This analysis was carried out using desktop and literature research, interviews, workshops and discussions, the results of which were processed and compiled by the project consortium. It provides the basis for further exchange with all stakeholders involved. The report specifically identifies those fields of action that should and must be addressed in the "Education and Training Roadmap for Austria" to be developed. Finally, it is the goal of the ReBUSk project to

draw up an optimally coordinated education and training roadmap until 2030 for the future of the building sector in Austria.

2 Objectives and methodology

The aim of this status quo analysis is to provide all necessary information for a well-founded discussion between the experts and stakeholders involved and thus for the subsequent joint development of the national education and training roadmap for achieving the energy and climate targets in the building sector in Austria. The analysis includes information about the current state of the energy policy and legal framework as well as the status quo of the Austrian building sector and presents the existing framework conditions in education and training as well as the results of an evaluation of the implementation of the first national roadmap until 2020. It also examines the skills gaps and qualification needs as well as possible barriers and opportunities related to the qualification of professionals in the building sector that could promote or hinder the achievement of the energy and climate goals in this field.

The methodology used to prepare the status quo analysis comprises five subtasks, which are outlined below. Detailed explanations of the methodology and the data used can be found in the respective subsections.

1. Update and expansion of the status quo analysis from the first BUILD UP Skills initiative

The basis for this first task is the status quo report (Bittersmann, et alii, 2013) that was prepared as part of the "BUILD UP Skills Austria" project of the first BUILD UP Skills initiative (2011 to 2013). The document was fundamentally revised, updated and expanded to reflect the current framework conditions and the broadened focus. It was expanded to encompass the qualification of blue-collar professionals and the consideration of the entire education and training sector of the relevant occupational groups (including architectural design, specialist planning, engineering, project and real estate development, building operation and facility management, et cetera) across all qualification levels of the National Qualifications Framework (NQF). Based on several workshops with the interdisciplinary project team (consisting of experts and researchers from the building and energy sector, as well as from educational science) to define the system boundaries, the work for this task was mainly carried out in the form of desktop research. Other means included the processing and analysis of secondary data (mainly data from Statistics Austria and results of existing studies) and supplementary interviews with experts and representatives from the building and education sector.

The results provide a detailed overview of the current energy policy and legal framework (Chapter 3), the status quo of the Austrian building sector (Chapter 4) as well as the existing framework conditions in education and training (Chapter 5), each with a focus on achieving the European and national energy and climate targets in the building sector.

2. Evaluation of the implementation of the first National Qualification Roadmap

The second task in the preparation of the status quo analysis included an evaluation of the implementation of the measures outlined in the "Roadmap Education and Training of Skilled Workers in the Construction Industry" from the first BUILD UP Skills initiative (Fechner & Selinger, 2013) that focused on the education and training of blue-collar workers in the building sector.

The analysis and evaluation were conducted in the context of team workshops, each preceded and followed up by desktop research. The evaluation results and lessons learned for the development of the new national education and training roadmap to 2030 are presented in Appendix III: Evaluation of the national roadmap until 2020.

3. Definition of future scenarios for the Austrian building sector to achieve the energy and climate targets

In this task, based on an in-depth framework analysis of existing laws, directives, regulations and other relevant documents at national and European level, two future scenarios were developed for the Austrian building sector. Not only directly relevant topics such as energy efficiency, renewable energies or circular economy were taken into account, but also indirectly effective areas of influence such as demographic, environmental protection policy, economic and technical developments. Based on desktop research and team workshops, the scenarios were developed in cooperation with experts from the building and energy sector. One of the two scenarios was then selected and evaluated in workshops with experts, practitioners and stakeholders from the building sector, education and training and labor market research in terms of the probability of specific developments and their necessity in order to reach the energy and climate targets. The results from this process are presented in Chapter 7.2.3.

4. Gap analysis to define current and future skills needs

Building on the results of the previous tasks, a gap analysis was carried out to determine the current and future qualification needs for achieving the energy and climate targets in the building sector. The basis for the gap analysis are the results of a competence analysis of the existing education and training system carried out by the project team (Chapter 5.4). This involved analyzing whether and to what extent relevant skills and competences related to increasing energy efficiency, using renewable energies, resource efficiency and circularity in the building sector, as well as boosting the renovation rate and decarbonizing the building stock, are already reflected in current educational regulations, curricula and course descriptions of existing training and education programs.

In addition, workshops were held with experts, practitioners and stakeholders from planning, construction, and real estate, as well as from education and training, to find out how they assess the knowledge, skills and competences needed by the various groups involved in the relevant fields of action. The results of the gap analysis are presented in Chapter 7.2.4.

5. "SWOT" analysis to identify barriers and opportunities

In the last task, a SWOT analysis was started to identify strengths (S), weaknesses (W), opportunities (O), and threats (T) in the presented status quo that are related to the qualification of professionals in the building sector and that could promote or hinder the achievement of the energy and climate goals in this sector. For the SWOT analysis, the most important topic areas were first identified in team workshops. For this, the following data were used: status quo analyses of the energy policy and legal framework conditions of the building sector, existing framework conditions in education and training, evaluation of the first national roadmap, results from workshops conducted with experts, practitioners and stakeholders from the building sector, education and training, as well as labor market research.

The results of the SWOT analysis, together with the status quo analysis itself, will form an essential basis for the development of the national qualification roadmap to 2030. At the time of finalizing this report, the SWOT analysis is still in progress, but initial results are already presented in Chapter 8.

3 Energy policy and legal framework

In the following chapter, the political framework conditions and strategies in Austria are examined with regard to the European climate and energy targets until 2030. The focus is on the legal framework for increasing energy efficiency and renewable energies in the building sector. National measures and strategies to promote green skills and green jobs are discussed in Chapter 5.5.3. Information about the national implementation of the European Qualifications Framework (EQF) can be found primarily in Chapter 5.1.2.

Austria's energy policy is based on the requirements and directives of the European Union.

3.1 Cornerstones of European energy policy

3.1.1 Background and vision

The decision of the Paris Agreement in 2015 increased the pressure on efforts to prevent global temperatures from rising more than 2°C above pre-industrial levels (and to keep it below 1.5°C as much as possible). The intensification of discussions and the introduction of new visions and strategies at the European level led to new targets set for the period up to 2050, which tighten the existing framework.

Climate and Energy Package 2020

Europe had set itself the target of reducing its greenhouse gas emissions by 20% by 2020 compared to 1990, as part of the "Climate and Energy Package 2020"[2] adopted in 2009. This target was achieved on average in the EU, albeit not by all countries (Anderl, et alii, 2022, page 97 and the following), but had to be redefined to meet the ambitions of the Paris Agreement. The accompanying "Roadmap for the transition to a competitive low-carbon economy by 2050" (Communication COM/2011/0112 final, 2011) from 2011 also needed a rewrite in this context.

Clean energy for all Europeans package

Therefore, long-term strategies were drawn up in 2018, aiming at emission reductions of 80–100%, in line with the Paris Agreement. In 2019, the "Clean energy for all Europeans package"[3] was adopted. This package led to a revision of numerous directives and included the Regulation on "Governance Regulation" (Regulation (EU) 2018/1999, 2018). This regulation provides in particular for steering and monitoring measures to meet climate targets and is still

[2] https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2020-climate-energy-package_de#documentation, retrieved on 23.02.2023
[3] https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en, retrieved on 30.03.2023

in force today. By 2019, each member state had to prepare a national energy and climate plan (NECP) and a long-term strategy (LTS). These must also be updated regularly, or progress must be reported on a regular basis.

EU Green Deal and Renovation Wave

As part of the negotiations on long-term strategies, the European Parliament adopted the resolution on the **EU Green Deal**[4] in December 2019, which aims to make Europe the first climate-neutral continent by 2050. With this in mind, the interim target is a 55% reduction in greenhouse gas emissions by 2030 compared to 1990. The Green Deal also contains numerous policy initiatives that affect all greenhouse gas emitting sectors.

The Green Deal places particular focus and ambition on the buildings sector, which is responsible for 36% of the EU's energy-related greenhouse gas emissions. With a building stock that is 75% energy-inefficient and in need of renovation (European Commission – Department: Energy, 2020) energy renovation is a key success factor to achieve the climate targets for Europe. In order to push the renovation of buildings, the European Commission has launched the initiative "Renovation Wave"[5] (including a corresponding action plan) in 2020. This initiative focuses on three areas:

- Tackling energy poverty and retrofitting worst-performing buildings
- Rehabilitation of public buildings and improvement of social infrastructure
- Decarbonization of heating and cooling

The Renovation Wave initiative builds on national long-term building renovation strategies and feeds into the revision of related guidelines as well as the building-related aspects of each EU country's national energy and climate plan (NECP).

3.1.2 Laws and guidelines

European climate protection law

The European Climate Law (Regulation (EU) 2021/1119, European Climate Law, 2021) came into force in June 2021 to implement the ambitions of the Green Deal through concrete targets for the EU and its member states and to establish a legal framework for its two main objectives:

- Achieving climate neutrality by 2050
- Reducing greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels

The entire European legal framework (directives, et cetera) must now be revised to ensure that it is in line with these targets and secures the path to achieving them. To this end, the

[4] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en, retrieved on 30.03.2023
[5] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en, retrieved on 30.03.2023

European Commission proposed the "Fit for 55" legislative package in summer 2021[6], which provides a legal framework for achieving the climate targets, taking into account both social and economic aspects. The Council agreed on concrete proposals in June 2022 and negotiations on the final legislative texts are now underway in Parliament.

The adoption of this legal framework will initially lead to a tightening of the emissions trading system and the Effort Sharing Regulation (Regulation (EU) 2023/857, 2023), both of which will have an impact on the construction sector, particularly on the social and financial aspects of the energy transition.

In addition, the introduction of the "Fit for 55" legislative package makes it necessary to revise numerous directives, especially those relating to the construction sector.

European Building Efficiency Directive

Above all, the European Building Performance Directive (Energy Performance of Buildings Directive 2010/31/EU, EPBD, 2012) sets out basic measures for achieving a highly energy-efficient and decarbonized building stock. The national implementation of this directive has already led to successful results: According to the European Commission, with the introduction of energy efficiency provisions in national building codes, newly constructed buildings consume only half as much energy in operation as typical buildings from the 1980s.[7]

The latest revision of the EPBD was adopted in 2018 as part of the "Clean energy for all Europeans" package, adding to the Directive requirements for long-term building retrofit strategies and the introduction of smart readiness indicators (SRI) for buildings and building automation and control systems.[8]

To reflect the high ambitions of the Green Deal, the European Commission presented a proposal for a recast of the EPBD on December 15, 2021, which aims to set out the path towards a zero-emission and fully decarbonized building stock by 2050. The measures proposed accordingly are essentially as follows:

- From 2030, all new buildings must be emission-free and climate-neutral; new public buildings must already be emission-free and climate-neutral by 2027.
- The worst 15% of the EU building stock must be improved from energy efficiency class G to at least F by 2030, with public and non-residential buildings leading the way. Residential buildings are to be upgraded from G to at least F by 2030 and to at least E by 2033.
- The obligation to present an energy certificate is extended to all public buildings as well as to buildings that have undergone major renovation or buildings whose lease is being extended. Buildings or building units that are offered for sale or lease must, in principle, present an energy certificate.

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[6] https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/, retrieved on 30.03.2023
[7] https://commission.europa.eu/news/focus-energy-efficiency-buildings-2020-02-17_en, retrieved on 30.03.2023
[8] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator/what-sri_en, retrieved on 01.05.2023

- Charging infrastructure for electric vehicles in residential and commercial buildings must be expanded and parking spaces for bicycles promoted.
- National building retrofit plans will be fully integrated into national energy and climate plans to enable both comparability and monitoring of progress. Roadmaps for phasing out the use of fossil fuels for heating and cooling will be included by 2040 at the latest.
- A "renovation passport" for buildings is designed to make it easier for consumers to plan a gradual renovation toward climate neutrality.

Crucially, the revised directive will enable targeted investments in the buildings sector, complementing other EU instruments to support low-income households and tackle energy poverty. It will work hand in hand with other initiatives in the European Green Deal package, in particular the proposed new emissions trading scheme for fuels used in buildings, the Energy Efficiency Directive, the Renewable Energy Directive, and the Alternative Fuels Infrastructure Regulation.

The proposed revision of the Directive is now under consideration by the Council and the European Parliament (as of April 2023). The European Parliament's latest agreement on the European Buildings Directive was published in February 2023.

Energy Efficiency Directive

The Energy Efficiency Directive (Energy Efficiency Directive 2012/27/EU, EED, 2012) completes and supplements important aspects of the EPBD for the buildings sector. In its original version of 2012, this directive was part of the European strategy to reduce energy consumption by 20% by 2020. In December 2018, the directive was amended under the motto "Energy Efficiency First" by means of Directive (EU) 2018/2002. In line with the new climate targets of the Green Deal and with the introduction of the "Fit for 55" package, the Energy Efficiency Directive is currently being revised again, and the Commission has presented a proposal for the recast. The revision proposes to raise the binding energy savings target for primary energy consumption to 9% by 2030. The building sector is essentially addressed by the following measures:

- Public buildings: obligation of member states to renovate at least 3% of the total area annually and to reduce energy consumption by at least 1.7% per year
- Consumers and households: focus on energy efficiency measures in low-income households and households experiencing energy poverty
- Introduction of a legal obligation to prioritize energy efficiency in planning and investment decisions

The draft was presented on July 14, 2021. Currently (as of April 2023), trilogue negotiations are taking place between the Parliament, the Council and the Commission.

Renewable Energy Directive

A further and essential aspect of the European Green Deal is the expansion of renewable energy sources. In this regard, the Renewable Energy Directive (Renewable Energy Directive

2009/28/EC, RED, 2009) provides the European legal framework. Since its introduction in 2009, the share of renewable energies in energy consumption has risen to 21.8% in 2021 according to the European Commission.[9]

In its current version of 2018, the directive sets the overarching European target for the expansion of renewable energies and contains rules to push the use of renewable energies in the transport sector as well as in the heating and cooling sector. The directive also contains principles for the promotion of renewable energy and for legal frameworks to produce and consume renewable energy and to establish energy communities, and sets sustainability criteria for the use of biomass. The directive also includes provisions for the promotion of renewable energy and identifies ways in which citizens, consumers and businesses can participate in the transition to renewable energy.

In connection with the introduction of the "Fit for 55" package", the Council and the negotiators of the European Parliament reached a preliminary political agreement at the end of March 2023, according to which the share of renewable energy sources in total energy consumption in the EU is to be increased to 42.5 % by 2030. Furthermore, an indicative additional increase of 2.5 % was provided for, with which a share of 45 % should be achievable. In particular, the integration of renewables into the grid (for example, development of new technologies, integration of storage) should be facilitated and electrification (for example, heat pumps and electric vehicles) and the inclusion of new fuels (such as renewable hydrogen) should be pushed more strongly. As far as the building sector is concerned, the following measures are particularly relevant[10]:

- Establishment of a benchmark of 49% for renewable energies in buildings
- Increase the use of renewable energies for heating and cooling by 1.1% per year

The Commission's proposed revision of the Directive is currently (as of April 2023) under consideration by the Council and the European Parliament.

3.1.3 Other instruments

In addition to adapting the legal framework, numerous European initiatives, plans and instruments aim to push the decarbonization of the construction sector. For example:

- **Monitoring**: Building Stock Observatory (BSO) is an observatory for monitoring the characteristics and energy performance of buildings in the EU.[11]
- **Financing**: The De-risking Energy Efficiency Investment Platform (DEEP) is an EU-wide open source database of track records for project developers, financiers and investors to better assess the risks and benefits of energy efficiency investments.[12]

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[9] https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en, retrieved on 31.05.2023
[10] https://www.consilium.europa.eu/de/press/press-releases/2023/03/30/council-and-parliament-reach-provisional-deal-on-renewable-energy-directive, retrieved on 31.05./2023
[11] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory_en, retrieved on 23.02.2023
[12] https://deep.eefig.eu, retrieved on 23.02.2023

- **Training**: Through special training sessions, webinars, publications and country fact sheets, the European portal BUILD-UP provides extensive information to stakeholders in the building sector.[13]
- **Funding**: The "NextGenerationEU Recovery Plan" is a temporary tool to boost the economy after the Covid pandemic, focusing on those areas that will make Europe greener, more digitalized and more resilient.[14]
- **Social aspects**: The Commission's recommendations on combating energy poverty (Recommendation (EU) 2020/1563, 2020) are part of the strategy of the Renovation Wave initiative. These provide guidance on the selection of appropriate indicators to measure energy poverty, promote the exchange of best practice examples between EU countries, and highlight the potential for accessing EU funding programs that prioritize vulnerable groups.

3.2 Energy strategy in Austria and legal framework

Long-term strategy 2050 – Austria

In December 2019, the Austrian government submitted the "Long-term Strategy 2050 – Austria" to the European Commission (BMNT, 2019b), in accordance with the European Governance Regulation (Regulation (EU) 2018/1999). In this, Austria committed itself to the goal of becoming climate-neutral – without the use of nuclear energy – by 2050 at the latest.

National energy and climate plan (Nationaler Energie- und Klimaplan – NEKP)

In parallel, as well as for the concrete implementation of the European climate protection targets, the Austrian National Energy and Climate Plan (NEKP) was developed within the framework of the EU climate protection package (BMNT, 2019a). This comprehensive strategic plan was also adopted by the Austrian federal government in December 2019 and subsequently submitted to the European Commission. This plan includes the goal of reducing greenhouse gas (GHG) emissions in Austria by at least 36% by 2030 compared to 2005 levels. Furthermore, the NEKP defines concrete measures and targets in the areas of energy efficiency, renewable energies and mobility. For example, the share of renewable energies in gross final energy consumption is to be increased to at least 46% by 2030 and storage capacities are to be expanded to ensure a stable and secure supply of renewable energies.

In addition, this plan places a special focus on the building sector with the aim of reducing greenhouse gas emissions by 3 million t CO_2-eq compared to 2016. Together with the promotion of building renovation, the phase-out of fossil fuels for heating and cooling and the expansion of district heating networks are planned.

In order to monitor the implementation of the NEKP and to ensure that the planned targets are achieved, a corresponding progress report is published every two years. The Austrian National Energy and Climate Plan is currently being revised (as of February 2024).

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[13] https://www.buildup.eu/en, retrieved on 23.02.2023
[14] https://commission.europa.eu/strategy-and-policy/recovery-plan-europe_en, retrieved on 23.02.2023

3.2.1 Austrian Energy Policy

Austrian Climate Protection Act

Beyond the EU targets, Austria intends to achieve climate neutrality as early as 2040. The existing legal framework for implementing the national and European climate targets in concrete terms is provided by the Austrian Climate Protection Act (Klimaschutzgesetz – KSG, 2013). The KSG was adopted in 2011 to meet the 2020 climate protection targets under the EU burden-sharing decision and was last amended in 2017. The government program 2020–2024 envisages a comprehensive revision of the KSG to set the path for the 2040 climate neutrality target, on the one hand, and to implement the tightened EU-level targets nationally, on the other. A corresponding bill is currently being drafted (as of February 2024).

Energy Efficiency Act

The Energy Efficiency Act (Bundes-Energieeffizienzgesetz – EEffG, 2014) forms the second pillar in Austria for the implementation of European and national energy policy, alongside the KSG. The act came into force in 2014, with an amendment in 2020. In order to meet the increasing energy efficiency requirements of the EU (see Energy Efficiency Directive), the EEffG is currently being revised. A revised draft (Energieeffizienz-Reformgesetz 2023 – EEff- RefG 2023, 240/ME, 2022) is currently before parliament for review (as of May 2023). In the buildings sector in particular, the draft provides for the continuation of final energy audits and energy management systems for large companies, individual consumption meters including remote reading requirements, and support for households (financially and through increased advisory services) in the implementation of energy efficiency measures.

Cross-sector initiatives

Beyond the legal framework, numerous cross-sector initiatives have been launched in Austria to pave the way for achieving Austria's climate targets:

- klima**aktiv** (BMK, 2023): The initiative was launched in 2004 on behalf of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft – BMLFUW) and within the framework of the Austrian Climate Strategy. klima**aktiv** acts in the fields of renewable energy (heat, energy wood, renewable raw materials, heating plants), energy saving (hints and knowledge for companies and households), mobility (support and knowledge for companies, communities and households) as well as building and renovation. Furthermore, klima**aktiv** Bildung (education) develops and organizes courses for professionals in cooperation with continuing education and training providers.
- The **e5 program**[15] for energy-efficient municipalities supports Austrian municipalities in structured and sustainable climate protection work. Participating municipalities receive tools and support under the program to set and achieve their energy and climate protection targets.

[15] https://www.e5-gemeinden.at/e5-programm/das-e5-programm, retrieved on 23.02.2023

- **Just Transition** – Action Plan Education and Training: As the transformation of society toward a low-emission and resource-efficient economy also affects the labor market, the skill requirements for employees, job entrants, and job seekers will inevitably change. The action plan "Just Transition" (Lindinger, et alii, 2023) sets out concrete measures for education and training in the energy and heating sector (see Chapter 5.5.3).

3.2.2 Austrian legal framework in the building sector

The Austrian legal framework for reducing greenhouse gas emissions in the building sector essentially covers aspects of construction quality (new construction and refurbishment), heating and cooling strategy, and the use and generation of renewable energies. It is based on the specifications and directives of the European Union.

In this context, the implementation of the EU Building Efficiency Directive (EPBD) takes place through various laws of the federal government and the federal states. In Austria, the federal states are responsible in particular for the building codes and related regulations. As a coordination platform in the field of construction, the Austrian Institute for Building Technology (OIB) has drawn up guidelines for this purpose, which reflect the requirements of the EU directives at the national level.

OIB Guideline 6 – Energy saving and heat insulation

On the topics of energy saving and thermal insulation, OIB Guideline 6 (Österreichisches Institut für Bautechnik – OIB, 2019) specifies minimum requirements that must be met for new construction as well as for major renovations. The guideline contains detailed specifications for the energy efficiency of the building envelope as well as requirements for the building services engineering. The currently applicable version of OIB Guideline 6 is the 2019 edition, with a further update already in progress.

Energy Performance Certificate Template Act (Energieausweis-Vorlage-Gesetz – EAVG)

Furthermore, the Energy Performance Certificate Submission Act (EAVG, 2012) regulates the preparation and submission of energy performance certificates for buildings when they are rented, sold or leased. It first came into force in 2008 and has been revised several times, in particular to integrate new requirements of the EU Energy Performance of Buildings Directive (EPBD).

National long-term renovation strategy (Langfriststrategie – LFRS)

The issue of building renovation is central at the EU level and, in particular, anchored in all member states through the obligation to submit a national long-term renovation strategy following the EPBD (Mikulits, Thoma, Stadler, 2020). This document first analyzes the existing national instruments and measures to push cost-optimal deep renovation of buildings, reduce energy poverty and increase the use of smart technologies in buildings. Also included in the LFRS is a roadmap of actions and measurable progress indicators related to the long-term goal of reducing EU greenhouse gas emissions by 80–95% by 2050 compared to 1990. In addition, the LFRS analyzes the tools to support investment mobilization in terms of facilitating access. The LFRS was first published by the OIB in April 2020. The strategy will be updated

every three years and submitted to the EU Commission as part of the national energy efficiency action plan.

Renewable Heat Act (EWG)

A large part of the heating and cooling demand for buildings in Austria is still covered by fossil fuels. In addition to improving building efficiency, Austrian policy aims to reduce CO_2 emissions from buildings by switching to renewable energy sources. The Renewable Heat Act (Erneuerbare-Wärme-Gesetz – EWG) aims to regulate the switch from old fossil fuel heating systems to modern, climate-friendly alternatives. With the Federal Act on the Renewable Heat Supply in New Buildings (Erneuerbare-Wärme-Gesetz, 2024), which came into force on 29 February 2024, the installation of heat supply systems based on fossil fuels in new buildings is no longer permitted (although transitional provisions apply to properties under construction). No regulations are set out in the EWG for installations in existing buildings.

Renewable Expansion Act (Erneuerbaren-Ausbau-Gesetz – EAG)

The conversion of heating and cooling to renewable energy sources requires a correspondingly massive expansion. In this context, the Renewable Expansion Act 2021 (EAG, 2021) was passed replacing the Green Electricity Act. It provides the legal framework to achieve the goal of converting to 100% electricity from renewable energy sources by 2030. Among other things, the EAG simplifies the expansion of photovoltaic systems on buildings and enables the establishment of energy communities.

Other instruments

Beyond the legal framework, other instruments in Austria support the implementation of highly efficient buildings and the switch from fossil to renewable energy sources. For example:

- The klima**aktiv** initiative already mentioned (see Chapter 3.2.1) offers several instruments for promoting energy-efficient construction and renovation, especially in the building sector. For example, it offers consulting services and opportunities for quality assurance for sustainable new construction and building renovation. In addition, the klima**aktiv** building standard was developed to make the sustainability of a building measurable and comparable. Numerous practice-oriented continuing education opportunities are also offered for the area of construction and renovation.
- The development of an Austrian action plan for sustainable public procurement (naBe action plan)[16] was adopted in 2010 as part of an initiative of the European Commission. This plan provides for the public sector to assume a special exemplary role by fulfilling certain criteria in its procurements. For example, public buildings (new construction and refurbishments) are to achieve at least the silver klima**aktiv** building standard in the future. On June 23, 2021, the federal government adopted an updated naBe action plan (including naBe core criteria).

[16] https://www.nabe.gv.at/, retrieved on 23.02.2023

- Numerous funding streams are offered by the federal and state governments to support energy retrofits and the conversion of heat generation to renewable energy sources. For example:
  - As part of the renovation offensive, thermal renovation in private residential buildings is promoted by the "renovation check"[17] , with funds made available annually for this purpose by the Austrian federal government. Companies and municipalities can also apply for subsidies for this purpose.
  - The "Get out of oil and gas" promotion campaign[18] is also a successful initiative to support the switch from fossil-fueled space heating systems to sustainable heating systems for private homes as well as for businesses and municipalities. Due to its great success in previous years, the "Get out of oil and gas" funding campaign will be continued in 2023 and 2024, and will continue for another two years as part of the nationwide renovation campaign.

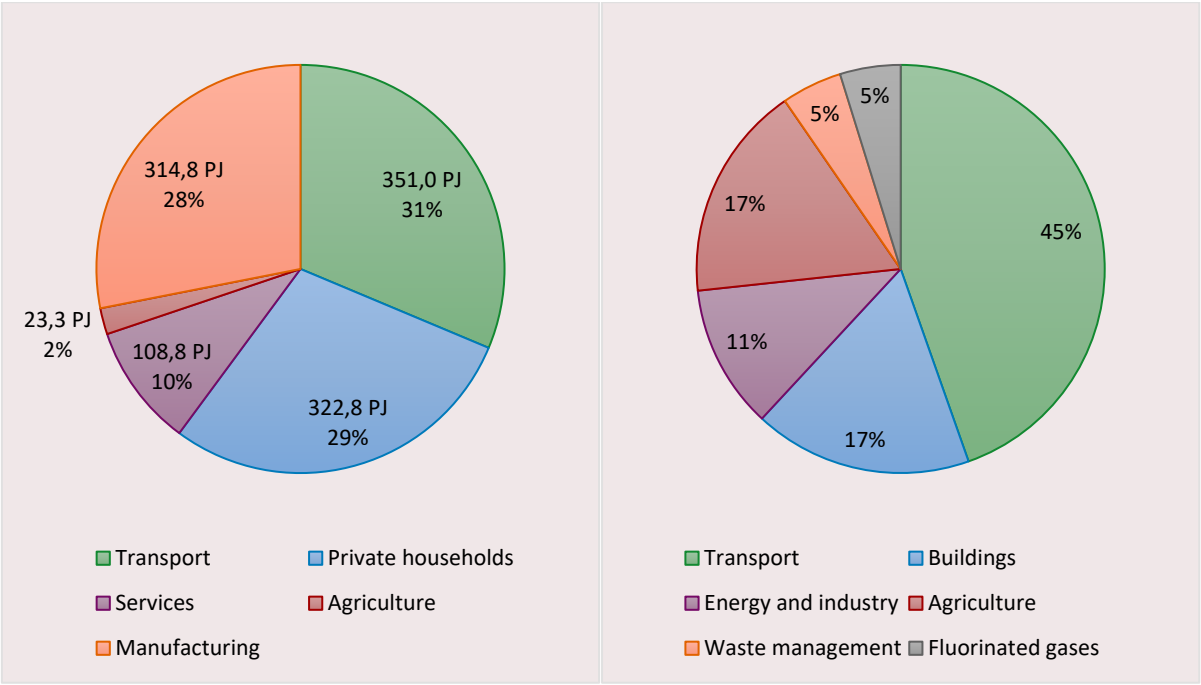
[17] https://www.umweltfoerderung.at/privatpersonen/sanierungsscheck-ein-zweifamilienhaus-und-reihenhaus-2021/2022, retrieved on 23.02.2023
[18] https://www.umweltfoerderung.at/privatpersonen/raus-aus-oel-und-gas, retrieved on 23.02.2023

4 Analysis of the building sector

4.1 Statistics and analysis of the building stock

In Austria, the building sector is responsible for approx. 17% of greenhouse gas emissions, whereby "embodied carbon" emissions from construction and maintenance as well as from the dismantling of buildings are not included. Thus, the building sector is the second most emitting sector after transportation (see Figure 1 right). Thanks to efforts to improve the energy efficiency of buildings, to increase renovation activities and to switch energy supply from fossil to renewable energies, emissions in the building sector have decreased by 36% since 1990. However, private households are still responsible for almost 30% of final energy consumption in Austria (Figure 1, left).

Figure 1: left: Final energy consumption in Austria in petajoules 2021 and share of sectors; right: Share of sectors in greenhouse gas emissions 2020 (without emissions trading)



Source: Own illustration based on data from Anderl, et alii (2022)

Emissions in the building sector are distributed differently among the individual states, reflecting their specific challenges (Anderl, et alii, 2022). In urban areas such as Vienna, the share of fossil fuels is still high, but per capita emissions are relatively low because the area is densely built-up. Rural regions, on the other hand, have higher per capita emissions, which is due to the larger usable area per capita.

In general, three aspects can be cited as the main contributors to greenhouse gas emissions and energy consumption in the building sector in Austria:

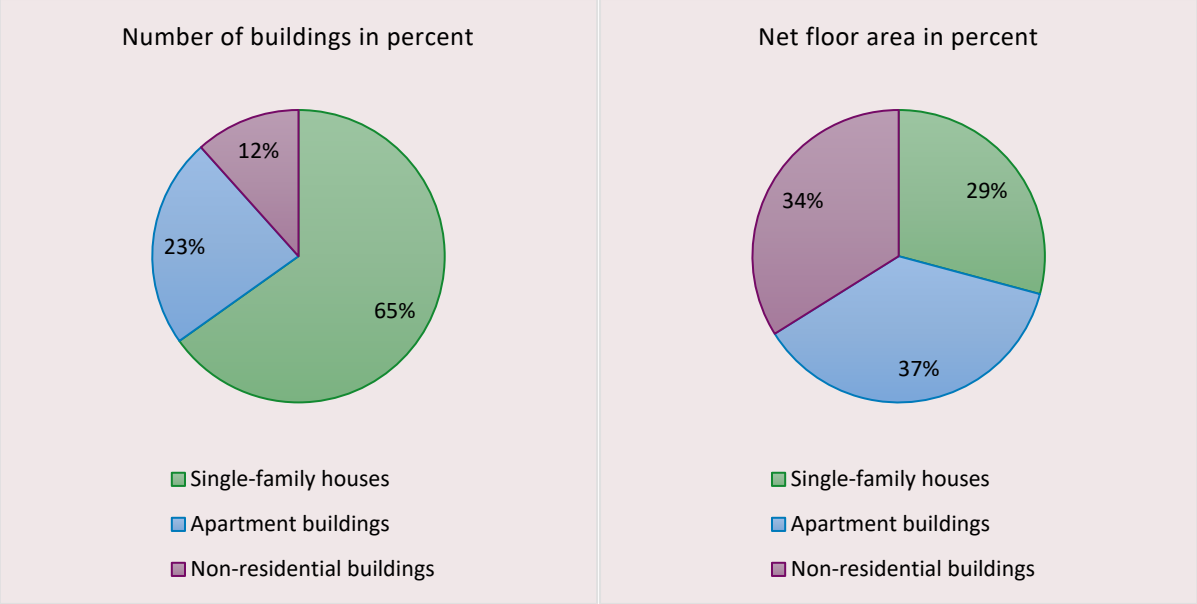
- Increase in floor space per capita: More living space directly leads to more energy consumption for building operation and heating.
- Quality of the building envelope: Unnecessary energy losses in room conditioning occur due to poorly insulated walls, floors, roofs or windows, thermal bridges or insufficient air tightness.
- Type of heat generation: The combustion of fossil fuels for heat generation leads directly to greenhouse gas emissions.

In the following paragraphs, the Austrian building stock is analyzed with regard to these three aspects.

4.1.1 Built-up area

The living ideal of a "single-family house" is particularly popular in Austria, resulting in a high share of single-family houses in the building stock (see Figure 2).

Figure 2: Share of building types in percent (left: number of buildings; right: net floor area)



Source: Own illustration based on data from Statistics Austria (2011)

With an average net floor area of over 200 m², single-family houses account for one third of the total net floor area built in Austria (Anderl, et alii, 2022). Moreover, the trend toward more floor space per capita continues to rise: compared to 1990, usable floor space per dwelling has increased by more than 50%. Furthermore, the number of primary residences has increased by 36% during this period, while the population has increased by only about 16%.

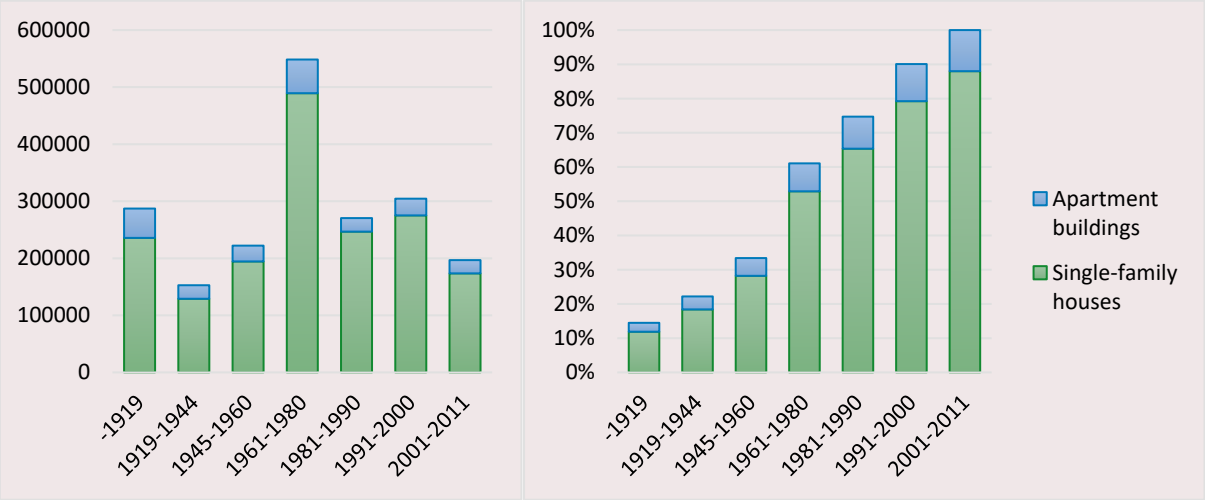
An increase in the number and size of single-family homes per capita leads to higher absolute energy consumption for their heating and operation. This trend counteracts the successes achieved in the other areas (quality of the building envelope and type of heating) to reduce greenhouse gas emissions in the building sector. In addition, this trend is often accompanied by an increase in road traffic and the number of private cars, which also makes it more difficult to achieve climate targets.

4.1.2 Building envelope quality

The quality of the thermal envelope has a direct impact on the amount of energy needed to heat, cool, and operate buildings, and thus has a significant impact on greenhouse emissions from the building sector.

Figure 3 shows construction activity by time period (left: absolute; right: cumulative) in Austria. Similar to many European countries, about half of Austria's building stock dates back to the period before the first oil crisis and a large part of it to the post-war period.

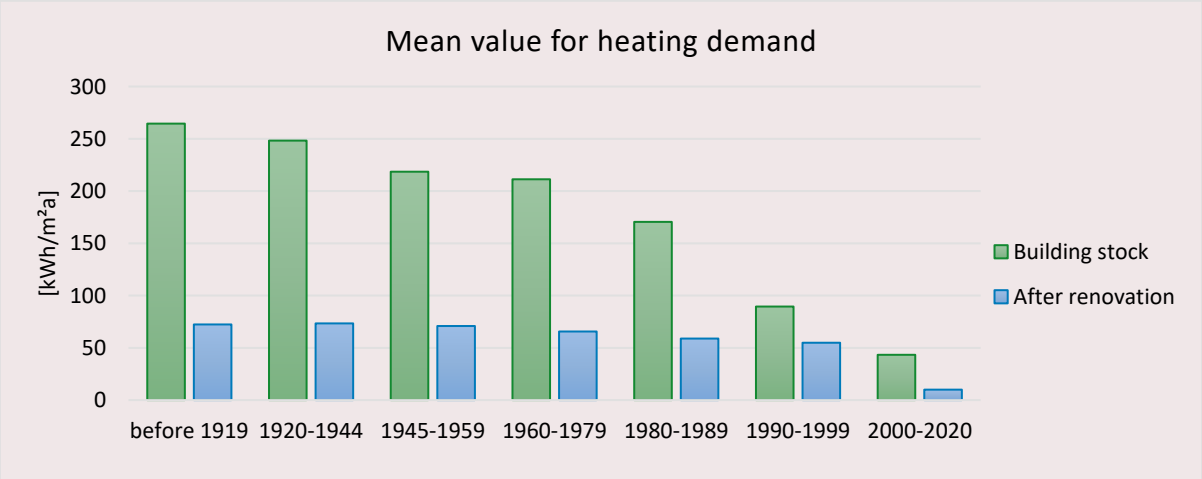
Figure 3: Number of residential buildings built by period (left: absolute; right: cumulative)



Source: Own illustration based on data from Statistics Austria (2011)

These buildings typically have high heating requirements especially when non-renovated (see Figure 4).

Figure 4: Typical heating demand for residential buildings by building age and refurbishment status

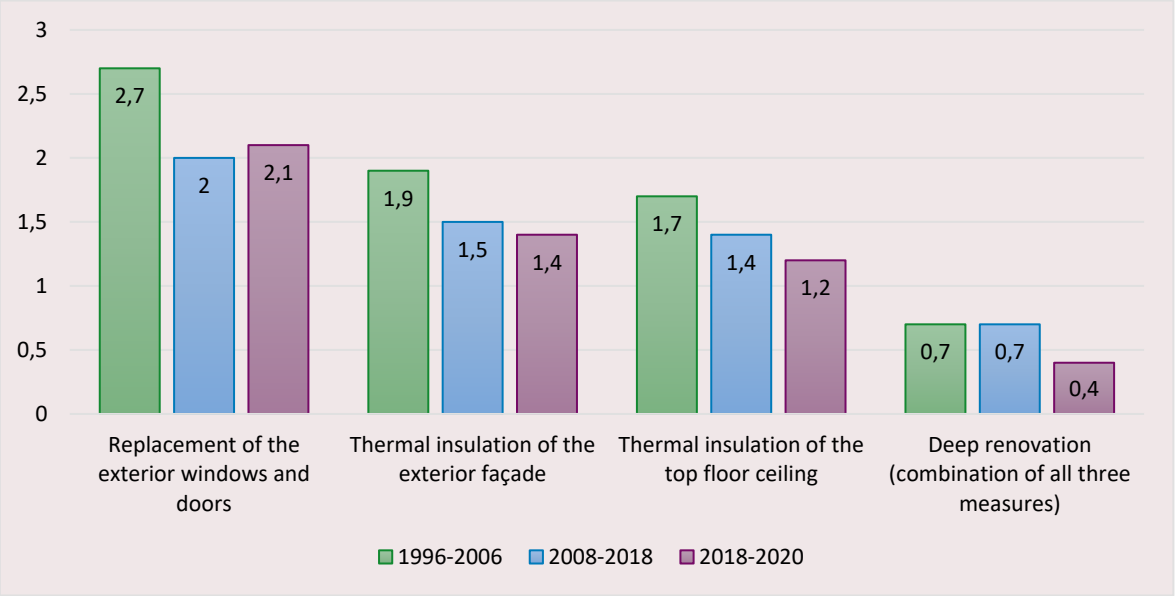


Source: Own illustration based on data from Episcope.eu[19]

[19] https://episcope.eu, retrieved on 07.03.2023

These figures underline that a decisive energy-saving potential lies in the thermal renovation of Austria's building stock. Renovation rates over the last 30 years indicate that thermal refurbishment in Austria is carried out on a relatively small scale (with the renovation rate having decreased even further between 1996 and 2020). In particular, complete (deep) thermal refurbishments are carried out rarely.

Figure 5: Average renewal rate per year for Austrian primary residences



Source: Own illustration based on data from Anderl, et alii (2022)

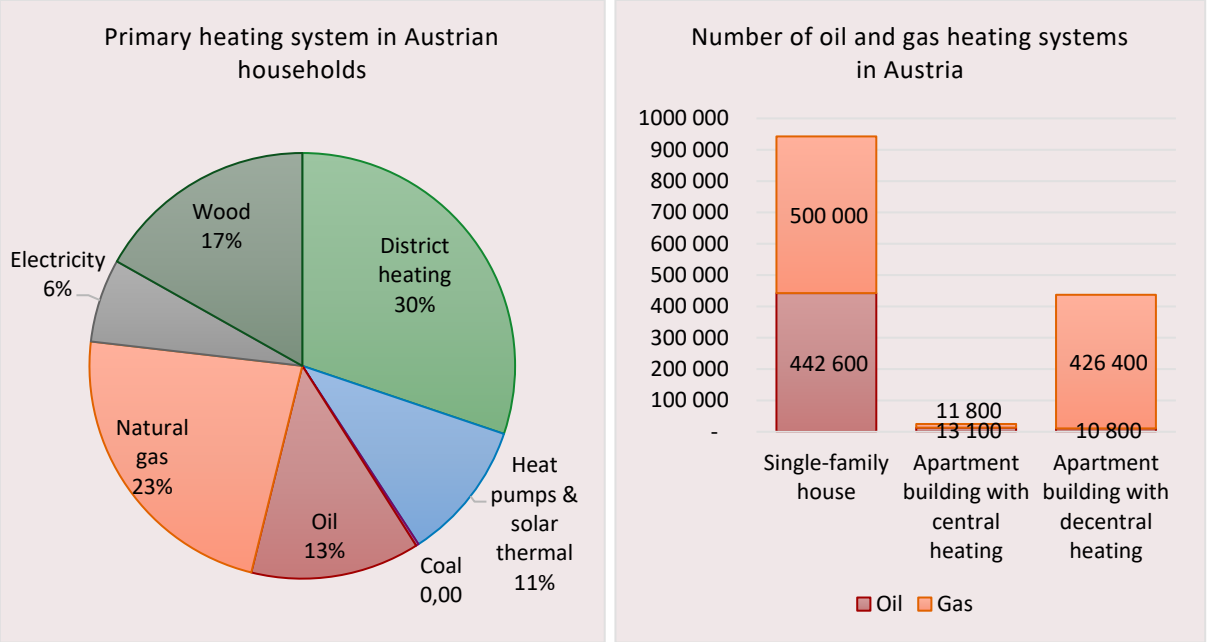
In this context, it should also be noted that, depending on the depth and quality of the refurbishment, "lock-in" effects could occur beyond the actual reduction in heating demand. A typical "lock-in" situation occurs, for example, when a building component is refurbished with insufficient thermal quality. This inadequately refurbished condition will remain blocked ("locked") for the next few years, resulting in the loss of relevant potential energy savings during this time.

4.1.3 Heating type

After the reduction of the heating demand, the type of heating, especially the phasing-out of fossil fuels for heat generation, has an important impact on the reduction of greenhouse gas emissions in the building sector.

The following chart shows the primary heating systems used in Austrian households and a breakdown of oil and gas heating systems by building type. This illustrates that more than one third of Austrian households still primarily heat with fossil fuels. Oil and gas heating systems are primarily used in single-family homes in rural areas and in apartment buildings (decentralized gas boilers) in urban areas.

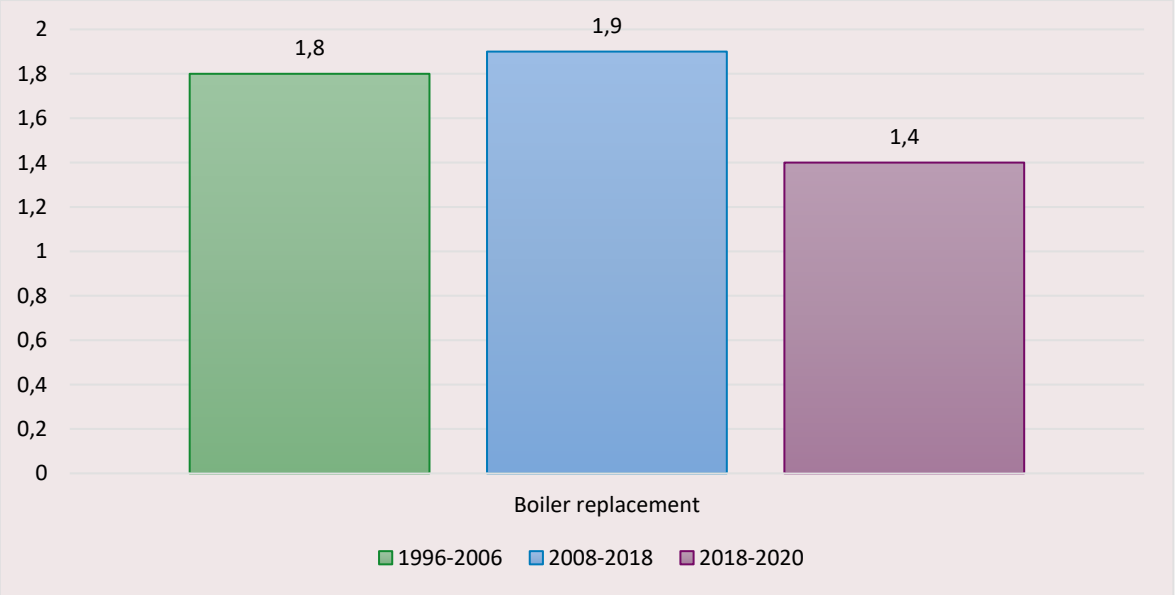
Figure 6: Primary heating system in households and number of oil and gas heating systems in Austria



Source: Own illustration based on data from the Federal Environment Agency (2021)

Like the thermal refurbishment rate, the boiler replacement rate in Austria is also at a low level (see following figure), although the federal and provincial governments have increasingly provided financial incentives and subsidies in recent years to push boiler replacement (see subsidy campaign "Get out of oil and gas", https://www.umweltfoerderung.at/privatpersonen/raus-aus-oel-und-gas, retrieved on 03.08.2023).

Figure 7: Mean rate of boiler replacement per year for Austrian main residences



Source: Own illustration based on data from Anderl, et alii (2022)

Especially the replacement of decentralized gas floor heating systems in multi-family houses is currently accompanied by significant technical and bureaucratic challenges.

4.1.4 Summary

Ninety percent of Austria's building stock consists of residential buildings, 65% of which are one and two-family houses. The strongest construction activity in Austria was recorded in the period from 1961 to 1980, with the largest share of residential space in all periods being created by one and two-family houses. Today, a large proportion of these buildings are in need of renovation.

The requirements for the quality of the building envelope have increased significantly in recent years. This is due, on the one hand, to compliance with national and international guidelines on energy saving in the building sector and, on the other hand, to increasing demands on living comfort. Supported by scientific findings as well as technological developments, the professions and players in the sector have changed accordingly. Energy consulting, building simulation and quality assurance, for example, are among the services that increasingly accompany the construction process. Regarding building components, trends in Austria are moving more towards lightweight, degradable and recyclable construction methods (for example, timber construction), highly efficient windows and prefabricated systems, which enable fast and cost-efficient assembly, especially in refurbishment. However, almost three quarters of Austrian buildings that were built before 1980 have received hardly any energy refurbishment measures so far. These renovation tasks represent Austria's largest construction site for the coming years.

However, improper energy refurbishment of the building envelope or refurbishment by untrained professionals can also result in undesirable structural damage, especially in the area of connections, such as in the case of improperly performed window replacement as a single measure (see Chapter Construction faults).

In addition, Austria's goal of climate neutrality by 2040 and the current energy crisis are leading to a rapid transformation in the heating sector. The centralization and replacement of fossil-fueled heating systems, with which one third of Austrian households still generate their heat directly, is leading to a "boom" in alternative systems. Compared to 2005/2006, for example, the number of households heated by heat pumps has increased tenfold. The need for qualified personnel in both the planning and execution of renewable technologies has also risen sharply.

Due to climate change, Austria is increasingly affected by heat waves in summer. Although the knowledge and technology for passive and active cooling measures are already available, this issue is still often of minor relevance, especially for residential buildings, and this increasingly leads to retrofitted, inefficient solutions.

Furthermore, the emerging developments in the field of Building Information Modeling (BIM) over the last few years are creating new trends towards digital construction. These developments have an influence on both the planning process and the associated required personnel qualifications. They enable improved quality control during construction

(avoidance of construction errors) and open up the possibility of building monitoring with a digital "twin", for example.

4.2 Construction faults

The survey of construction faults in Austria is an extensive and small-structured subject area. Accordingly, the literature research on this topic also proved to be exceedingly difficult. The last Austrian construction fault reports (1st to 4th) were published between 2005 and 2011. This means that in the last 12 years no reports on Austrian building damage have been published by the Construction Department of the Austrian Economic Chambers (WKO Geschäftsstelle Bau) and the Institute for Building Research (Institut für Bauforschung). In addition, the OFI, the Austrian Research and Testing Institute, is no longer involved in the publication of information and documentation on building damage issues, except for the preparation of expert reports. Statistics Austria does not collect detailed itemized data on building damage in the Austrian construction industry according to a query dated February 14, 2023.

In the course of research, building experts, large insurance companies, property developers/housing companies and technical universities in Austria were approached. These stakeholders were unable to provide written information due to various motives, among others, lack and confidentiality of data. Nevertheless, based on the information received and researched, an attempt will be made here to give a brief overview of the topic of building damage in Austria. For this purpose, the limited literature available was used and supplemented by the expertise and experience of surveyed experts, lecturers in the field of building damage, developers of building damage documentation software and the Energy Agency Styria. The building damage chapter of the ReBUSk Status Quo Report of 2013 served as the basis for this new revised chapter. Furthermore, literature from the DACH region (Germany, Austria and Switzerland) was also consulted, as few data are available for Austria and the construction industry of Germany and Switzerland can be compared to Austria (NEVARIS, 2022). In addition to information from the construction industry, the allocation of construction faults to standards and construction methods would also provide a basis for comparison. To provide an overview of the current distribution of building deficiencies in the building envelope, a study by PlanRadar was evaluated.

4.2.1 Proportion of construction faults in the building envelope

An overview of the distribution of construction faults in the building envelope is provided by an evaluation of the most frequently occurring construction faults by the software provider PlanRadar (PlanRadar, 2023).

According to this evaluation, problems occur most frequently in the area of the roof cladding. Fifteen point five percent (15.5%) of all construction faults are found here. A frequent fault is mold formation in connection with moisture due to a lack of insulation or the installation of wood for the construction of roof trusses that at the time of assembly still had a moisture value above the permissible standard value (PlanRadar, 2023). Flat roofs in particular have a high maintenance requirement; among other things, the roof waterproofing should be checked regularly to prevent consequential damage (Hubner, 2021).

Thirteen point seven percent (13.7%) of the identified construction faults occur in connection with ceilings and floors. Examples of this are laying a floor covering on unsuitable subfloor or parquet on underfloor heating, which forms joints due to the rising heat. In the case of ceilings, the plaster can crumble down if the primer is inadequate.

Construction faults in walls (12.1%) mostly occur in the form of cracks due to improperly processed joints or the use of faulty bricks.

Current observations show that the share of technical building equipment is steadily increasing. Accordingly, the risk of poor quality or faulty shoring is also increasing. Thus, it could be determined that almost 9.2% of all construction faults occur in connection with building technology (PlanRadar, 2023). Monsberger and Fruhwirt also point out the challenges related to building services in a 2018 study of the Austrian construction process (Monsberger & Fruhwirth, 2018).

Construction faults in windows and doors occur less frequently compared to 2013, but still account for 9.1% of faults; these are leaking windows and poorly closing or warped doors (PlanRadar, 2023), for example. However, these elements should be given great attention due to their location in the building envelope. This is because leaks in building envelopes, in particular, represent a great potential for consequential damage in addition to the immediate fault. Frequently observable problems occur at the connection directly to the window or door element, the flush connection to the living area, or the connection behind the window and door element. Similarly often as with windows and doors, construction faults also occur in the basement (9%). A common example in the basement area is moisture entering due to faulty sealing.

Construction faults on façades, terraces and balconies and in garages have a comparable share with about 5 to 6%. Façade defects would be cracks, discoloration and the use of incompatible materials. For terraces and balconies, the lack of waterproofing between them and the body of the building and the incorrect installation of decking boards represent the greatest potential for sources of faults. Cracks in the floor and too little or too much clearance to the garage door are problems that can be observed in the area of garages.

Four point nine percent (4.9%) of all construction faults originate in the foundation. This can lead to fractures in floors and walls, allowing moisture to penetrate, which often leads to mold growth.

In thermal and sound insulation elements, 4.1% of faults occur, for example, due to pipe penetrations or insufficient insulation of building components. Exterior installations account for only 3.6% of faults; improper drainage of rainwater, for example, is the reason for this. Construction faults affecting stairs account for 2.5%. The occurrence of harmful substances accounts for a small percentage, but is a serious fault (less than 0.1%).

According to this study, about one third of all faults (39%) could not be assigned to a specific area. The percentages evaluated here, therefore, refer to the 61% of faults that occurred in assignable components or areas.

PlanRadar (2023) lists five common causes of construction faults that occur:

- Shoring of inferior material
- Lack of control (lack of quality assurance)
- Lack of quality control or project review
- Complexity of construction project
- Lack of communication and information flow

Better internal construction project communication and coordination, a higher standard of quality control and evaluation, and improved reporting and complaint management in conjunction with greater use of technology and digitization should help increase the quality of the construction project and prevent the number of construction faults.

The skills shortage, which was mentioned several times by the respondents as one of the causes of structural damage, should also be mentioned in this context.

4.2.2 Recording of faults and monitoring instruments

The recording of construction faults and structural damage and the monitoring in this area is carried out, on the one hand, by the construction companies themselves and, on the other hand, by externally or internally commissioned experts. In Austria, there are currently 1,761 generally sworn and court-certified experts in the field of construction and building trades listed on the website of the Ministry of Justice[20] (justizonline.gv.at as of 20.3.2023).

Compared to 2013, there is an increased use of documentation software in construction damage documentation and monitoring. This is used during the construction process but also during the actual use of the building. It facilitates the documentation of the construction materials used and the exchange of data between different specialists and serves to keep records of construction damage (Stefan Grubinger, personal communication, March 2023).

Current technical developments increasingly enable new ways of recording and tracking structural damage. For example, the use of mobile devices with suitable software support, thermal imaging cameras, drones and the like are increasingly opening up new possibilities for detecting and documenting building damage both qualitatively and quantitatively. The use of sensors or fiber optic cables, for example, also provides further possibilities for detecting, locating and, above all, interpreting structural damage, especially in the case of long-term observations.

The individual documentation of faults of a construction project is sensitive and confidential; publication is mostly not in the interest of the client. This can be seen as a cause for the lack of available literature on building defects in the Austrian construction industry.

4.2.3 Conclusion

Research on this topic has shown that a new edition of an Austrian building damage report is necessary to carry out an exact analysis of the actual state of construction faults and building defect situation in Austria.

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[20] https://justizonline.gv.at, retrieved on 20.03.2023

In order to support a reduction of construction faults and structural damage in the medium to long term, this report could form a basis for a targeted allocation to trades. Weather extremes caused by climate change, such as heavy rainfall, dry periods, the lowering of the groundwater level in some regions or the decline of zones with permafrost, will pose new challenges in this area in the future and require a more in-depth examination.

Detailed data and analyses of the current state and the effects of construction faults and structural damage in the Austrian construction industry could serve as a basis for improvement measures and provide concrete evidence for targeted research, training and policy measures.

4.3 Industry and employment statistics in construction

Developments on the labor market in the construction industry can be mapped using industry and employment statistics. Data are available from various sources and refer to different classifications. For sector statistics, the annual evaluations of the Austrian Federal Economic Chambers (Wirtschaftskammer Österreich – WKO) are available. For employment statistics, data from the micro-census, which is regularly collected by Statistics Austria, can be used. For the presentation of unemployment, data from AMS Austria (Public Employment Service) are used.

4.3.1 Industry statistics

The WKO industry statistics are based on the classification system of the Austrian Federal Economic Chambers. The Construction Trade Association, which is the focus of this analysis, can be assigned to the trade and crafts sector. Other relevant specialist areas with separate statistics available are, for example, "Roofers, glaziers, tinsmiths", "Plumbers, tilers and ceramicists", "Painters and upholsterers", "Auxiliary building trades", "Timber construction", "Plumbing, heating and ventilation technicians", and "Electrical, building, alarm and communications technicians". In terms of employment volume, however, the Construction Trade Association is by far the most important, so the analysis focuses on this area.

Table 1: Industry statistics according to various characteristics

	2010	2015	2016	2017	2018	2019	2020	2021	Change 2010–2021	Change 2015–2021
Active professional group members (professional association construction)	11,968	12,959	13,306	13,712	14,193	14,732	15,321	16,262	35.9%	25.5%
Unemployed persons (excluding marginal employment)	76,131	78,923	81,538	82,842	87,178	91,019	88,005	94,329	23.9%	19.5%
Employees	20,314	22,823	23,366	24,031	25,567	26,664	26,672	28,403	39.8%	24.4%
Workers	55,437	56,822	59,102	59,902	62,361	64,879	61,944	66,653	20.2%	17.3%

Apprentices	3,810	3,133	2,916	2,837	2,940	3,091	3,122	3,276	-14.0%	4.6%
Men	70,501	73,004	75,508	76,555	79,988	83,320	80,293	86,209	22.3%	18.1%
Women	9,059	9,774	9,876	10,215	10,879	11,314	11,444	12,123	33.8%	24.0%

Source: WKO Industry Statistics: Construction 2022. Own calculation and presentation

The Construction Trade Association has seen a rapid increase in active trade group members, that is, active companies operating in this sector, since 2010. Overall, there has been an increase of 36% between 2010 and 2021. Since 2015, this trade group has grown by 26%. There are also similar positive dynamics to be observed in all of the above-mentioned professional associations.

The growth in active companies is also reflected in the development of the employment volume. Since 2010 and 2015, there has been an increase of 24% and 20%, respectively. This comparatively strong employment dynamic can also be found in the professional associations "Wood construction", "Electrical, building, alarm and communication technicians" and "Auxiliary building trades", while the employment volume in the other professional associations is stagnating.

It is noteworthy that the volume of employment among white-collar workers (2015–2021: 24%) has increased more than among blue-collar workers (2015–2021: 17%), with strong growth in both sectors. This may be an indicator of the structural change in the construction industry, in which planning activities are becoming increasingly important. An analogous development can be seen in "Timber construction" and, to a lesser extent, in "Electrical, building, alarm and communications technicians". In some other sectors, there has been a stronger increase in the number of blue-collar workers (for example, "Roofers, glaziers, tinsmiths", "Auxiliary building trades").

Another interesting development is that while women are particularly underrepresented in the construction sector, employment growth among women has been stronger than among men. This may be a consequence of the expansion in the white-collar sector.

With regard to training activity in the sector, the development of apprenticeship numbers is particularly interesting. Between 2010 and 2021, a decline in training activity of -14% can be observed. However, a turnaround in apprenticeship training was initiated in 2017, which is again reflected in rising apprentice numbers. Since 2015, an increase of 5% has been observed after all. There is a similar development in the professional associations "Timber construction" (2015–2021: 24%) and "Auxiliary building trades" (2015–2021: 22%). However, there are striking declines in apprenticeship training in the trade associations "Painters and paperhangers" (2015–2021: -16%) and "Plumbers, tile layers and ceramicists" (2015–2021: -17%). There are slight declines in apprenticeship numbers in "Plumbers, heating and ventilation technicians" (2015–2021: -3%) and "Electrical, building, alarm and communications technicians" (2015–2021: -6%).

Table 2: Industry statistics for construction by company size

	Number of companies		Number of employees	
Company size classes (2021)	Quantity	Share	Quantity	Share
0–9	10,587	88%	13,504	18%
10–49	1,102	9%	22,991	31%
50–249	239	2%	23,336	31%
250 and more employees	35	0.3%	15,385	20%
Total	**11,963**		**75,216**	

Source: WKO Industry Statistics: Construction 2022. Own calculations. Size classification excluding marginally employed persons. The differences in the totals compared to the previous table cannot be traced in the WKO Industry Statistics.

The "Construction" sector is dominated by small businesses. Eighty-eight percent of trade group members have up to nine employees, and a further 9% have between 10 and 49 employees. However, this is naturally not reflected in the employment structure. Nevertheless, around half of the employees work in companies with fewer than 50 employees. In comparable specialist groups, the structure of companies is even more dominated by small commercial enterprises.

Subcontracting to foreign companies plays a significant role in Austria, both in the construction industry and in the building trade. In a study conducted by Amann, et alii in 2021, the share of foreign subcontractors in the construction industry was estimated at over 50%. In the construction industry, the share is lower, with complete lots from Romania, Croatia, Bosnia, and Poland often being used for individual trades. In the past, the increased use of foreign subcontractors has allowed for a strong boost in construction output with moderate price increases. However, it also brought with it challenges with regard to wage and social dumping, as well as an outflow of value added. For some time now, countervailing developments have been observed as construction activity in the sending countries has picked up significantly, resulting in increased earnings opportunities for construction companies and construction workers in the countries of origin (Amann, Goers, et alii, 2021, page 44)

4.3.2 Employment statistics

Central characteristics of employment structures in the construction sector can be mapped using data from the micro-census, which is provided and collected by Statistics Austria. Annual data is always published with a time delay. Depending on when individual sections of this section were composed, the latest available data was used. This explains possible deviations in the distributions of different tables. It should also be noted here that employment figures from other sources (such as AMS data) may be based on a different composition of the population. For this description of the employment structure, two special analyses were carried out for the years 2021 and 2022. These relate to employees in construction according to the economic activity of the employer as defined in the ÖNACE 2008 classification system. . ÖNACE 2008 differentiates down to four levels, with data only

publicly available for the top level. Since the classification differs significantly from the WKO's chamber classification, it also results in different employment totals. Of particular interest, however, is the employment structure in the construction sector with a total of 323,894 employees in 2021.

Table 3: Employment statistics in construction by socio-demographic and employment-related factors

		Employees in construction according to economic activity ÖNACE 2008	
Categories		**Employees**	**Share**
Total	-	323,894	
	Socio-demographic factors		
Gender	Male	280,582	87%
	Female	43,312	13%
Age	15 to 24 years	48,704	15%
	25 to 34 years	74,014	23%
	35 to 44 years	74,228	23%
	45 to 54 years	79,506	25%
	55 to 64 years	45,443	14%
	65 years and older	1,998	1%
Nationality	Austrian citizenship	250,487	77%
	Non-Austrian citizenship	73,406	23%
Highest education	Compulsory school	51,060	16%
	Apprenticeship diploma (vocational school)	184,402	57%
	Secondary vocational school (without vocational school)	24,691	8%
	High school	46,390	14%
	University, university of applied sciences, university-related educational institution	17,352	5%
	Acquisition-related factors		
Employment level (self-assessment)	Full-time employee	288,439	89%
	Part-time employee (< 30 hours)	35,454	11%
Occupation according to ISCO08	Managers <1>	10,537	3%
	Academic as well as comparable professions <2>	13,569	4%
	Technicians and equivalent non-technical professions <3>	55,814	17%
	Office workers and related professions <4>	25,484	8%
	Service occupations and salespersons <5>	2,032	1%
	Professionals in agriculture, forestry, and fisheries <6>	213	0%
	Craft and related trades <7>	175,368	54%
	Plant and machinery operators and assembly occupations <8>	19,597	6%
	Elementary occupations <9>	21,208	7%

Source: Micro-Census Labor Force Survey Annual Data. Retrieved from STATcube – statistical database of Statistics Austria on 01.02.2023.

Similar to the industry statistics, the employment statistics also show that women are strongly underrepresented in the construction industry. Only 13% of employees are female. In terms of age, the distribution between 25 and 54 years is relatively balanced. Among the younger age group, a training activity may be noticeable. In the 55–64 age group, which is also underrepresented, retirement effects are likely to play a role.

Twenty-three percent of persons employed in construction have non-Austrian citizenship. The share may be underestimated here, as only persons who have a residence in Austria participate in the micro-census. Commuters from abroad are therefore not taken into account. A special AMS analysis shows a share of 32% of employed persons in the construction sector, with an upward trend (Wach, 2022).

The highest level of education is dominated by apprenticeships (57% of employees). Sixteen percent have only completed compulsory schooling. Fourteen percent of employees have a secondary school diploma, while 8% have a middle school diploma, which is less relevant. Five percent have a tertiary degree.

Full-time employment is largely the standard employment model in the construction industry. Eighty-nine percent of employees are employed full-time according to self-assessment. Only a minority of 11% consider themselves to be in part-time employment.

Corresponding to the apprenticeship training, the construction industry is dominated by the occupational group of craft and related trades (according to the International Standard Classification of Occupations – ISCO-08, 54%). Technicians and similar occupations represent the second largest occupational group with 17% of employees. It is noteworthy that unskilled workers account for only 7%, while 16% have only a compulsory school leaving certificate. Here, semi-skilled jobs may have been classified as skilled work activities.

In order to be able to make comparisons between countries in a European context, the funding organisation required employment figures for each occupation to be categorised according to predefined occupational categories and national employment figures to be reported in this system. However, a precise translation of Austrian professions for the specified English terms (Architects, Designers, Civil engineers, Structural engineers, Electrical engineers, Mechanical engineers, Building services & HVAC engineers, Building site inspectors, Building surveyors, Building Managers, Energy Assessors, Other(s) as needed) is not possible due to the country-specific professional system. Instead, the internationally recognized standard ISCO-08 (International Standard Classification of Occupations) serves as a reference framework for occupational classification and translation for the following employment statistics. In a further special evaluation of the microcensus for the reference year 2022[21], the employments numbers of those occupations that are directly related to the construction of a buildings were broken down into the ÖNACE 2008 divisions of building construction, civil engineering, and other construction activities. The employment figures reported here are based on an extrapolation of the microcensus. As this only represents a sample of the total population, the extrapolation contains a corresponding degree of imprecision. According to the recommendations of Statistics Austria, estimates of less than 3000 are not considered

[21] This data enquiry was made at a time when the most recent figures were already those for 2022.

statistically interpretable. Corresponding cells are labelled with "N". Occupational groups that comprise less than 3000 persons in the extrapolated total number were not listed in the table.

A further restriction of the database query is that at most data on the level of the "minor group" (corresponding to the third digit of the ISCO-08 code) is provided. It is therefore only possible to specify the occupations summarised in this subgroup cumulatively.

Table 4: Employment statistics in construction (ÖNACE 2008 divisions F41, F42, F43) broken down into ISCO-08 groups.

Breakdown according to ISCO-08	Number of employees in construction (ÖNACE 2008)				Percentage
	Building Construction	Civil Engineering	Other construction activities	Total in construction sector total	
Engineering Professionals (excluding Electrotechnology) <214>	4.600	4.300	N	8.900	3 %
Electrotechnology Engineers <215>	N	N	N	N	N
Architects, Planners, Surveyors and Designers <216>	N	N	N	N	N
Physical and Engineering Science Technicians <311>	7.700	5.200	15.000	27.900	11 %
Mining, Manufacturing and Construction Supervisors <312>	10.700	3.300	5.100	19.100	8 %
Process Control Technicians - Optical and Electronic Equipment Operators <313>	N	N	N	N	N
Building Frame and Related Trades Workers <711>	24.400	9.700	26.600	60.700	24 %
Building Finishers and Related Trades Workers <712>	5.000	N	53.800	58.800	23 %
Painters, Building Structure Cleaners and Related Trades Workers <713>	N	N	13.200	13.200	5 %
Sheet and Structural Metal Workers, Moulders and Welders, and Related <721>	N	N	N	N	N
Blacksmiths, Tool-Makers and Related Trades Workers <722>	N	N	4.000	4.000	2 %
Machinery Mechanics and Repairers - Machinery Mechanics and Fitters <723>	N	N	N	N	N
Handicraft Workers - Precision Workers in Metal and Related Materials <731>	N	N	N	N	N

Breakdown according to ISCO-08	Number of employees in construction (ÖNACE 2008)				Percentage
	Building Construction	Civil Engineering	Other construction activities	Total in construction sector total	
Electrical Equipment Installers and Repairers <741>	N	4.500	25.600	30.100	12 %
Electronics and Telecommunications Installers and Repairers <742>	N	N	N	N	N
Wood Treaters, Cabinet-makers and Related Trades Workers <752>	N	N	5.200	5.200	2 %
Other Craft and Related Workers <754>	N	N	N	N	N
Mining and Mineral Processing Plant Operators <811>	N	N	N	N	N
Other Stationary Plant and Machine Operators <818>	N	N	N	N	N
Assemblers <821>	N	N	N	N	N
Car, Van and Motorcycle Drivers <832>	N	N	N	N	N
Heavy Truck and Bus Drivers <833>	N	N	N	N	N
Mobile Plant Operators <834>	N	3.800	5.300	9.100	4 %
Mining and Construction Labourers <931>	8.600	5.600	3.100	17.300	7 %
Transport and Storage Labourers <933>	N	N	N	N	N
Total	61.000	36.400	156.900	274.900	
Percentage	22%	13 %	57 %		100 %

N: Statistically not interpretable

Source: Microcensus Labour Force Survey annual data. Retrieved from STATcube - Statistical database of Statistics Austria on 01/02/2024, Economic activity ÖNACE 2008

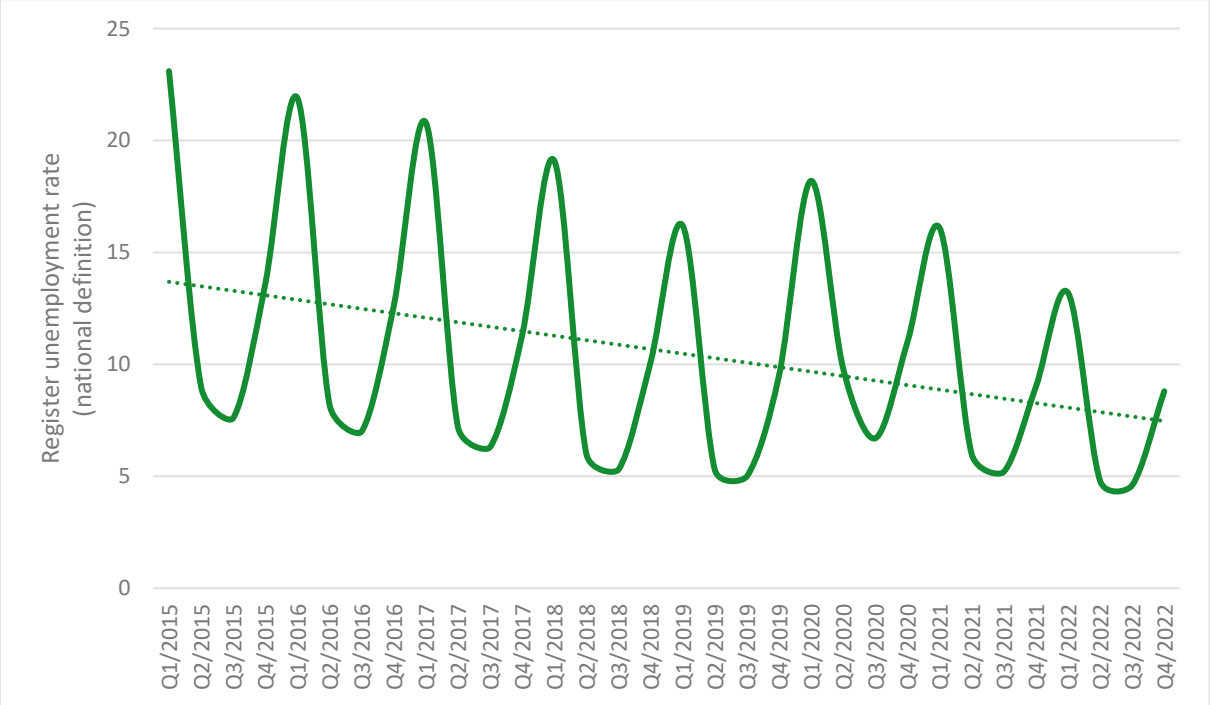
Around half of those employed in the construction sector are assigned to the occupational subgroups "Building Frame and Related Trades Workers" (24%) and " Building Finishers and Related Trades Workers" (23%). Planning professions, such as Physical and Engineering Science Technicians (which also include civil and structural engineers), make up a smaller proportion at an estimated 11%. Particularly rare, at around 2%, are " Blacksmiths, Tool-Makers and Related Trades Workers" in the construction sector. Labourers, site managers (production managers in construction) and painters ("Painters, Building Structure Cleaners and Related

Trades Workers") are employed in the sector in comparable proportions of less than 10%. " Electrical Equipment Installers and Repairers" appear somewhat more frequently at 12%.

In the marginal distribution of the construction industry divisions, most people are employed in "Other construction activities" at around 156,900 (57%), followed by building construction, which roughly covers slightly less than half of these at 61,000 (22%). Civil engineering accounts for 36,400 (13%) employees.

The labor-market situation in the construction industry is characterized by seasonal unemployment cycles. Unemployment rates are highest in December, January and February. Between April and October, however, the rates are low by comparison. However, the overall trend since 2015 has been downward, although the pandemic-related restrictions interrupted this development in the short term. According to the AMS assessment, the construction sector has thus shown itself to be surprisingly resistant and reacted relatively little to the massive economic slumps caused by Corona (Wach, 2022).

Figure 8: Development of unemployment rate by quarter in construction according to ÖNACE 2008



Source: AMS Labor Market Information System of the Federal Ministry of Labor and Economy. Retrieved on 08.04.2023. Table: Register unemployment rates – stock

The AMS estimates that higher energy and raw material prices could have a significant impact on staffing requirements. Supply chain problems could also lead to interruptions in construction activity. However, the AMS sees new impetus precisely in decarbonization and associated investments, which could lead to increased personnel requirements.

5 Existing framework conditions in education and training

In the following chapter, the existing framework conditions in Austria in the field of education and training for the building sector are presented. For this purpose, Chapter 5.1 first provides a thematic classification and delimitation, as well as an overview of the national implementation of the European Qualifications Framework. In the following two chapters (5.2 and 5.3), the existing structures in the field of education and training are presented, each with a focus on vocational training, qualifications, and competences related to the achievement of energy and climate goals in the building sector.

Section 5.4 includes the results of a competence analysis. For this purpose, training regulations, curricula, course descriptions, et cetera were analyzed in order to assess to what extent the current system already considers relevant competences.

Chapter 5.5 provides an overview of existing national and regional instruments, initiatives, measures, and projects related to the qualification of specialists for the building sector.

5.1 Background

5.1.1 Terminology: Blue versus white-collar

In the status quo analysis of 2013, the analysis was limited to apprenticeship training in the blue-collar sector. Due to the increasing complexity in the realization of energy-efficient buildings, the focus turned to other occupational areas of education and training that are involved in planning and realization and are commonly grouped under the term "white-collar workers". However, the distinction between blue and white-collar occupations is analytically untenable. For example, there are occupations that are at the interface of both fields (for example, a master builder may be involved in both planning and execution). The differentiation of both areas according to types of training is not useful either. For example, there are relevant apprenticeship occupations that cannot be assigned to the blue-collar area (for example, real estate agent).

Therefore, both blue-collar and white-collar occupations are included in the present analysis, but no analytical differentiation is made.

5.1.2 NQF as a tool for depicting the training landscape

National Qualifications Framework

With the National Qualifications Framework (NQF) an instrument was created to classify qualifications of the Austrian education system[22]. The basis is the NQF Act of 2016, which follows the recommendations of the EU on the European Qualifications Framework (EQF) and its eight qualification levels. It regulates the assignment of Austrian qualifications based on learning outcomes to one of the eight qualification levels of the NQF (Bundesgesetz über den Nationalen Qualifikationsrahmen, 2016).

Learning outcomes are statements of what a learner knows, understands, and is able to do after completing a learning process. They are defined as knowledge, skills, and competences (*Empfehlung des Europäischen Parlaments und des Rates zur Einrichtung des Europäischen Qualifikationsrahmens für lebenslanges Lernen*, 2008).

The eight NQF qualification levels, which build on one another, are defined by descriptors that specify the level of knowledge, skills and competences required to achieve a qualification at the respective level. Competence is understood in the sense of assuming responsibility and autonomy. The assignment of a qualification to an NQF level serves as orientation but does not automatically entitle the holder to access training courses at another/higher level.

The aim of the NQF is to create a transparency instrument that, on the one hand, facilitates orientation in the Austrian education system and, on the other hand, contributes to the comparability of national qualifications in Europe.

Assignment to NQF qualification levels

The NQF Coordination Unit (NCU) is responsible for assigning qualifications to one of the eight levels. For formal qualifications, that is, those that are regulated by law or ordinance, assignment requests are submitted to the NQF Coordination Point (NCP) by the competent ministry or the competent office of the provincial government. In the case of non-formal qualifications, education providers contact one of the NQF service units in order to submit the assignment request to the NCP, where it is reviewed in terms of content and form.

Currently, formal qualifications in particular are assigned to one of the NQF levels, while continuing education from the non-formal education sector is still hardly assigned, especially in the technical field[23]. Qualifications of the Bologna architecture are regulated based on the descriptors for the European Higher Education Area according to the NQF law: Bachelor's degrees at NQF level 6, Master's degrees and diplomas at NQF level 7 and doctorates and PhDs at NQF level 8. Basic qualifications are located at NQF levels 1 and 2, degrees from technical and commercial schools and apprenticeships at NQF level 4, diplomas from vocational colleges such as technical upper-level secondary school and commercial high

[22] https://www.qualifikationsregister.at/, retrieved on 02.11.2023
[23] NQF Register at https://www.qualifikationsregister.at/nqr-register/, retrieved on 02.01.2023

school at NQF level 5, engineers and master craftspersons at NQF level 6 and clinical or health psychologists at NQF level 8.

5.1.3 Trend towards competence orientation

The current teaching and learning culture is strongly characterized by a competence orientation. Siebert (2003) defines competence as follows: Competences are life-historically acquired profiles of emotion and cognition, of experience and knowledge acquisition, of thinking, willing and acting. Competences are largely acquired 'en passant' in the course of life, they are hardly ever taught and learned in a seminar-like manner – even though seminars can be a training ground for competences. Accordingly, competence is described as the learnable ability to act adequately in specific situations (North, et alii, 2013, page 43).

According to Hasebrook, et alii (2018), life phases are increasingly multidirectional, diverse, and volatile due to societal and economic changes and the resulting necessary adaptations to the labor market. Consequently, the use of dynamic and flexible competence development concepts is necessary to ensure participant-oriented and life-phase (further) development (Hasebrook & Zinn, 2018, page 5). Against the backdrop of a changing society, the teaching of relevant competences is indispensable and thus represents a central element of the European Pillar of Social Rights. This pillar states that all people should have access to high-quality education that enables them to make an important contribution as citizens in an active and self-confident manner in order to drive forward developments of our time: the digital and sustainable transformation. Based on this, fundamental reforms of the education system and its orientation toward future-oriented knowledge and skills are unavoidable. Vocational education in particular is compelled to drive sustainable reforms in order to ensure the availability of future professionals. Practical relevance, new learning tools, the use of digital technologies, and target group orientation must be incorporated into innovative teaching and learning formats. Micro-credentials can be a possible answer to this.

Micro-credentials are qualifications that demonstrate learning outcomes that are acquired in short formats with traceable assessment. As such, they have the potential to promote flexible learning and career paths across the lifespan and working years. In Europe in particular, these learning formats are already widespread, although both the uniform definition and the framework for their use are only marginally represented. Current developments show a movement toward micro-credentials frameworks, as examples from Europe, the United Kingdom, Australia, and New Zealand indicate. Derived from these efforts, micro-credentials can be seen as enablers for the targeted, flexible acquisition of knowledge and skills to meet new and emerging needs in society and the labor market.

The developments just described require continuous training. The term "lifelong learning" (LLL) has become established in this context. According to a study by the Austrian Federal Economic Chambers in 2022, 44% of 1,013 respondents stated that lifelong learning was very important, but only 30% implemented this strategy (Statista, 2023). The results of this survey highlight the need for comprehensive strategic reform and cultural change in adult education. This demand can be substantiated by the 2019 Statistics Austria survey, according to which the participation in education and training measures of 15 to 64-year-olds in the last four weeks before the survey in 2019 was 10.5% overall. In 2020, this number decreased by 3%

(to 7.5%). This appears to be primarily due to the Corona pandemic. In 2021, continuing education activities increased again and reached 10.4% in total (Statistics Austria, 2023c).

5.1.4 Target definition and thematic delimitation

The thematic delimitation for the present analysis took place in a multi-stage process of team-internal workshops, desktop research, and discussions to reach a consensus. In a first step, a compilation of possible relevant professions and industries was made. It was based on the topic delimitation of the status quo analysis of the BUILD UP Skills Austria initiative (Bittersmann, et alii, 2013), a supplementary desktop research, and the analysis of industry and sector directories of the Austrian Economic Chambers (WKO)[24]. Other data were the occupational information systems of the Public Employment Service (AMS)[25] and the online portal for career planning of the WKO.[26]

Based on this, an internal team workshop was held as part of the project kickoff meeting. During the meeting, the team formulated an initial joint target definition for the national roadmap to be developed, identified relevant occupations and industries and their influence on target achievement and discussed possible system boundaries for the required analyses. The common target definition was thereby determined as follows:

> *"The aim of the roadmap is to ensure the necessary competenies (skills) for achieving the national energy and climate targets in the building sector by 2030 (and beyond). For this purpose, an action and measure plan for the education and training sector is developed, which addresses competences for the following areas:*
>
> - *Increasing energy efficiency and the use of renewable energies in buildings*
> - *Establishment of Zero Emission Buildings (ZEBs)*
> - *Increase the rate of refurbishment and decarbonization of the building stock*
> - *Increasing resource efficiency and circularity in the building sector*"

The workshop activities were based on the following question:

> *"Which occupations and industries have a relevant impact on achieving the roadmap's goals?"*

Based on this preliminary work and the workshop results, a list of possible relevant occupational profiles from the following occupational areas was drawn up, based on the AMS occupational classification system:[27]

- Construction, auxiliary building trades, wood, building services engineering

[24] https://www.wko.at/branchen/Branchenauswahl.html, retrieved on 13.01.2023
[25] https://bis.ams.or.at/bis/berufe-nach-berufsbereichen#berufsklassifikation-ansicht-element, retrieved on 13.01.2023
[26] https://www.bic.at/berufsgruppen.php?bg=1#1, retrieved on 13.01.2023
[27] https://bis.ams.or.at/bis/berufe-nach-berufsbereichen?expand=84,84_271, retrieved on 13.01.2023

- Office, marketing, finance, legal, security
- Mechanical engineering, automotive, metal
- Cleaning, housekeeping, semi-skilled and unskilled jobs
- Environment

The compilation was narrowed down to approximately 80 occupational profiles in a multi-stage consensus-finding process involving experts from the Department of Construction and Environment at the University of Continuing Education Krems, the Austrian Energy Agency, the Styrian Energy Agency and the Sustainable Construction Working Group at Graz University of Technology. Each occupational profile was evaluated in terms of its relevance for target achievement (3 = high, 2 = medium, 1 = lower relevance). Strategically relevant occupational groups that indirectly influence the achievement of objectives but lie outside the defined system boundaries were marked separately.[28]

The result is a compilation of occupational profiles including information on the assessed relevance, typical qualification levels (NQF levels), as well as links to websites with detailed descriptions of the occupational profiles, which was used as a basis for the thematic delimitation in the following chapters (see Appendix I: Relevant professional profiles).

5.1.5 System of vocational education and training

The Austrian vocational education and training system

The vocational education and training system in Austria comprises a wide range of training and continuing education programs for different needs and interests. After completing compulsory schooling, which ends after the completion of the ninth school year, there is an obligation to complete training until the age of 18. At upper secondary level, students can choose between pre-vocational, vocational and general education courses.

Vocational qualifications can be acquired through either dual vocational training (apprenticeship) or school-based training. Tertiary-level training courses are offered at universities, universities of applied sciences, and teacher training colleges. They require a university entrance qualification, which can be acquired as a matriculation or diploma examination at a general or vocational secondary school (AHS, BHS) or via a vocational matriculation examination (Berufsreifeprüfung, BRP) or a university entrance exam(Studienberechtigungsprüfung). Non-university tertiary education programs are building craftsperson (Bauhandwerker) schools and industrial master (Werkmeister) schools.

Continuing education is broadly understood to include all forms of formal, non-formal and informal learning by adults after completion of an initial phase of education of varying length. Formal education includes courses of education offered by the regular school and university system that are based on legal regulations and lead to state-recognized qualifications. Non-formal or non-formal continuing education is understood to mean organized educational

[28] For example, spatial planning was identified as being outside the system boundaries. However, since it defines essential basics for building energy efficiency, the use of renewable energies, et cetera through its influence on development plans, definition of building standards, et cetera, it is of high strategic relevance for the defined objective.

offerings outside of formal curricula, such as courses, seminars, workshops, and the like. They can lead to qualifications that are not regulated by law but are recognized and usable on the labor market. In contrast, informal education is characterized by incidental learning in the context of life and work, such as the development of competences in the context of a work activity ("training on the job") or a voluntary commitment, without leading to an educational qualification.

Lifelong learning

All three learning settings (formal, non-formal, informal) are equally important for acquiring the knowledge and skills required to cope with and shape the current social and technological changes – key words: digitization/technologization, internationalization, and flexibilization of the world of work – in the sense of lifelong learning. From the perspective of lifelong learning and from a biographical perspective of the learners, a clear distinction between education and training phases is not always possible or meaningful. This can be illustrated by the project "Education of the Economy" and the educational paths of the Austrian Federal Economic Chambers (WKO)[29]. These paths map out coordinated educational pathways – from apprenticeship training to vocational schools and colleges to adult vocational training and academic programs offered by universities of applied sciences and universities. On the one hand, these educational paths trace the continuity of educational stages and predefined career paths. On the other hand, they show the possibility of combining individual sections or paths to obtain specialized qualifications and careers. For example, after completing an apprenticeship as a roofer and gaining one year of work experience, it is possible to complete an in-service training program as a foreman roofer in order to qualify as a manager, or to pursue a technical specialization through further training as a certified photovoltaic technician. Both qualifications offer the possibility of further qualification at a later stage to become a master roofer. Validation procedures also show the close interweaving of education and training phases over the lifespan in the sense of lifelong learning (see Chapter 5.3.5).

Distinction between education and continuing education

In this report, a distinction is made between education and continuing education as follows in order to avoid redundant presentations:

- Under **education** are subsumed the above-mentioned professional qualifications within the framework of apprenticeship, school and university education programs, regardless of whether they are completed in the first educational pathway or after an initial educational phase in the second educational pathway.
- **Continuing education** includes vocational and academic-science-oriented educational programs that build on completed initial vocational training. In addition to academic continuing education programs, these are primarily educational programs offered by professional associations and interest groups, private continuing education providers, or companies. Qualifications acquired in the second

[29] https://www.bildungderwirtschaft.at/bildungspfade/, retrieved on 17.01.2023

educational pathway (for example, extraordinary apprenticeship diploma) are assigned to the training system in this report. In addition, the focus is on organized continuing education in the formal and non-formal education sector.

In the following, the first step is to take a closer look at the training system with a focus on formal qualifications in the construction and building sector (Chapter 5.2). Chapter 5.3 on the system of organized continuing education deals with professional and scientific qualifications for specialists in the field of energy- and resource-efficient building sector, which are carried out in the state context by interest groups, private (product) providers, or companies. Furthermore, Chapter 5.3.5 deals with the accreditation and certification/validation structure in Austria.

5.2 System of training

The Austrian training system can be divided into three major areas: 1) dual training or apprenticeships, 2) apprenticeships with school-based (technical) training, and 3) tertiary forms of training. In the following, the occupational areas relevant to the building sector will be addressed in a differentiated manner (compare Chapter 5.1.3).

The dual education system in Austria

Apprenticeship training is a fully-fledged vocational training that is carried out at two learning locations (company and vocational school, therefore also called dual training)[30]. In this context, about 75% of the total training period is implemented directly in training companies and 25% in a vocational school. Vocational training is largely implemented directly in the process of work, that is, apprentices generally work productively in the respective training company during their training. The vocational school has a supplementary function for vocational training and is responsible for teaching general educational content. On a voluntary basis, however, there is still the possibility of selecting third learning locations (inter-company forms of training). This option is used in the construction industry. According to the collective agreement for workers in construction and the construction industry, all associated training companies must send their apprentices to so-called "training construction yards" or "Lehrbauhof" (run by construction academies in the respective federal states) for inter-company training (compare supplementary collective agreement to the collective agreement for the construction industry and the construction industry, as of 01.05.2022). For 3-year apprenticeships, the duration can be up to nine weeks, and for four-year apprenticeships up to twelve weeks.

Potentially, access to apprenticeship training is open to all young people who have completed the nine-year compulsory education period. For this purpose, an apprenticeship contract is concluded between the training company and the apprentice. Currently, around 40% of 15-year-olds start an apprenticeship[31].

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[30] A good overview of the dual system or apprenticeship training can be found here: IBW (2021). Apprenticeship. Dual vocational training in Austria. Vienna. The following presentation is based on this.
[31] compare WKO apprenticeship statistics 2021 – Demographic development. Reporting date: 31.12.2021

There are individually defined training regulations (job description, job profile, examination regulations) for each apprenticeship occupation. These define the training objectives (professional competences) that should be taught by the company during training for each apprenticeship occupation. At the end of the training period, the apprenticeship-leave exam can be taken. The apprenticeship occupations are classified at NQF level 4 according to the Austrian Qualifications Register[32].

There are currently 210 different apprenticeship occupations[33] in total. There are different types of apprenticeships: individual apprenticeships (163 apprenticeships), focus apprenticeships (30 apprenticeships), group apprenticeships (6 apprenticeships), and module apprenticeships (11 apprenticeships with 43 main modules and 34 special modules). The duration of apprenticeship training differs depending on the apprenticeship occupation: 2-year apprenticeships (7), 3-year apprenticeships (139), 3½-year apprenticeships (37), 4-year apprenticeships (16), and module apprenticeships with different apprenticeship durations (11). The regular review of the topicality of occupational profiles at 5-year intervals is enshrined in law.

Control of the apprenticeship system

Several groups of actors are involved at different levels in steering the apprenticeship training system. A key feature of the governance system is that, in addition to state institutions, social partnership actors are also involved.

At the federal level, apprenticeship training is regulated by law through the Vocational Training Act (Berufsausbildungsgesetz – BAG). The Federal Ministry of Economy decrees the training regulations for the individual apprenticeship occupations. The Ministry of Education is responsible for the regulation of the framework curricula for the vocational schools. In addition, there is also the Federal Vocational Training Advisory Board (Bundes-Berufsausbildungsbeirat – BBAB), which has equal representation of the statutory social-partnership interest groups (Austrian Federal Economic Chambers, Federal Chamber of Labor). The BBAB has an advisory function and prepares expert reports on behalf of the Federal Minister of Economy. As a rule, the BBAB is also involved in the development or revision of training regulations. As a rule, the development of training regulations is carried out with the involvement of vocational practitioners nominated by the social partners.

At the provincial level, the actors are operationally involved in the implementation of apprenticeship training in the respective provinces. The apprenticeship offices are responsible for the administrative handling of apprenticeship training (examination and documentation of apprenticeship contracts, organization of final apprenticeship examinations, financial support, counselling, et cetera). The provincial governors and corresponding offices act as supervisory authorities at the provincial level. The provincial advisory councils on apprenticeship training are staffed by social partners and have an advisory function. They also appoint the final apprenticeship examination boards. The

[32] https://www.qualifikationsregister.at, retrieved on 15.12.2022
[33] https://lehrberufsliste.bic.at/, retrieved on 01.09.2022

education directorates are responsible for vocational schools, that is, the implementation of the framework curricula.

At the local level, training is realized in concrete terms, that is, the training companies train apprentices to become qualified specialists in accordance with training regulations. Vocational schools are responsible for general educational training objectives and for supplementing the company-based practical training content.

Financing of apprenticeship training

The financing of apprenticeship training is shared. Training companies bear the costs for the company-based part of the training. These costs consist of the apprentice's wage (usually specified in collective agreements), the costs for the trainers and other training costs (materials, equipment, et cetera). However, the apprentices' work is usually also used productively in the company. This offsets a significant portion of the costs. If the apprentices continue to be employed in the company as qualified specialists after completing their training, there is usually a clear financial benefit for the training companies as a result of the training (Schlögl & Mayerl, 2016).

The costs for vocational schools are borne by the public sector. Furthermore, there is an extensive system of apprenticeship subsidies, which companies use both in the context of training activities (basic subsidy: up to three gross apprenticeship wages) and for quality-oriented measures (for example, additional qualifications, internships abroad, further training for trainers)[34]. In addition, there are funding opportunities through the Public Employment Service Austria for the training of disadvantaged young people or measures to abolish gender-specific training structures (for example, for the training of young women in occupations with a low proportion of women)[35].

Apprenticeships related to the building sector

Table 5: Development of selected apprenticeship occupations between 2015 and 2021

Selected apprenticeships	Imple-men-tation/ Update	2015	2016	2017	2018	2019	2020	2021	Share female (2021)
Construction technical assistance (AV)	2018	-	-	-	34	112	171	182	47%
Architectural drawing	2007	291	281	294	314	293	316	342	43%
Building waterproofing technology (AV)	2019	-	-	-	-	-	14	30	7%
Concrete construction	2019	-	-	-	-	-	219	464	1%

[34] https://www.wko.at/service/bildung-lehre/foerderungen-lehre.html, retrieved on 26.05.2023
[35] https://www.ams.at/unternehmen/service-zur-personalsuche/foerderungen/foerderung-der-lehrausbildung, retrieved on 16.05.2023

Selected apprenticeships	Imple-men-tation/ Update	2015	2016	2017	2018	2019	2020	2021	Share female (2021)
Precast concrete technology	2021	-	-	-	-	-	-	15	7%
Concrete production technology (expiring: 2021)	-	31	35	39	55	51	48	42	2%
Roofer	2019	751	732	666	672	657	649	688	3%
Retail – focus on building materials trade	2015	465	445	451	485	541	528	491	32%
Electronics	2011	924	849	786	745	736	716	714	14%
Electrical engineering	2010	8,585	8,741	8,751	8,937	9,249	9,455	9,734	6%
Disposal and recycling specialist	2021	-	-	-	-	-	-	6	17%
Waste disposal and recycling specialist – waste water	2021	-	-	-	-	-	-	4	25%
Waste disposal and recycling specialist – waste (expiring: 2021)	-	19	17	19	21	22	26	17	24%
Prefabricated house construction	2017	126	76	61	35	31	127	124	8%
Production measurement technology – focus on production control (AV)	2020	-	-	-	-	-	-	4	25%
Production measurement technology – focus on product measurement (AV)	2020	-	-	-	-	-	4	14	36%
Glass construction technology	2010	248	219	228	246	257	254	260	20%
Kiln maker	2015	194	141	83	78	71	69	59	8%
Building construction (AV)	2019	-	-	-	-	-	577	1,175	1%
Building construction specialist – focus on new construction (AV)	2019	-	-	-	-	-	19	43	2%

Selected apprenticeships	Imple-men-tation/ Update	2015	2016	2017	2018	2019	2020	2021	Share female (2021)
Building construction specialist – focus on renovation (AV)	2019	-	-	-	-	-	6	10	0%
Wood technology	2008	185	190	194	224	211	217	217	19%
Real estate agent (expiring: 2020)		132	126	129	143	150	99	38	61%
Real estate agent – focus on property development	2020	-	-	-	-	-	3	6	50%
Real estate agent – focus on brokers	2020	-	-	-	-	-	13	43	63%
Real estate agent – focus on property manager	2020	-	-	-	-	-	31	80	65%
Installation and building services engineering	2008	4,149	3,930	3,903	3,947	4,133	4,359	4,511	2%
Refrigeration technology	2009	301	297	306	316	364	401	432	4%
Design engineer – installation and building services engineering	2008	9	17	27	34	46	46	54	17%
Design engineer – electrical installation technology	2008	13	14	15	13	15	21	26	15%
Design engineer – mechanical engineering	2008	175	178	198	207	222	235	227	23%
Design engineer – metal construction technology	2008	39	49	54	55	58	48	43	21%
Design engineer – steel construction technology	2008	37	26	27	30	34	32	27	15%
Painter and coating technician – focus on decorative painting technology	2012	38	30	26	26	24	26	27	37%
Painter and coating technician – focus on functional coatings	2012	1,669	1,675	1,627	1,619	1,537	1,512	1,428	26%

Selected apprenticeships	Imple-men-tation/ Update	2015	2016	2017	2018	2019	2020	2021	Share female (2021)
Painting and coating technician – focus on historical painting techniques	2012	18	9	6	5	3	4	4	75%
Painter and coating technician – focus on corrosion protection	2012	4	6	7	10	5	3	3	0%
Bricklayer (expiring: 2022)	-	3,048	2,862	2,845	2,961	3,007	2,310	1,589	1%
Mechatronics	2022	2,110	2,259	2,458	2,677	2,892	3,027	3,092	11%
Metalworking	2022	441	475	505	488	461	424	384	9%
Metal technology	2022	11,707	10,918	10,742	10,840	10,889	10,619	10,300	10%
Furnace construction and installation technology	2015	36	64	98	118	113	116	122	7%
Tiler and slab layer	2015	525	505	474	490	489	481	494	5%
Formworker (expiring: 2019)	-	114	135	141	175	178	126	69	0%
Sun protection technology	2017	49	51	47	49	45	62	64	11%
Sheet metal worker	2019	587	549	504	483	495	495	487	5%
Plasterer and drywaller	2015	111	101	101	89	115	126	125	1%
Civil engineering	2019	216	214	246	284	357	413	478	2%
Civil engineering specialist – focus on construction machinery operation (AV)	2020	-	-	-	-	-	5	8	13%
Civil engineering specialist – focus on traffic route construction (AV)	2020	-	-	-	-	-	-	4	0%
Ready-mix concrete technology	2009	16	23	25	25	27	33	21	5%
Heat, cold, sound, and fire protection technology	2017	-	-	14	31	39	33	24	4%
Carpentry	2015	1,386	1,384	1,439	1,492	1,498	1,451	1,620	1%
Carpentry	2021	32	105	162	171	213	247	268	2%

Selected apprenticeships	Imple-men-tation/ Update	2015	2016	2017	2018	2019	2020	2021	Share female (2021)
Sum of apprentices in selected apprenticeships		38,782	37,728	37,698	38,624	39,631	40,216	40,733	9%
Total number of apprentices		109,963	106,950	106,613	107,915	109,111	108,416	107,593	32%

Source: Apprenticeship statistics of the Austrian Economic Chambers. Cut-off date in each case 31.12.
AV: Training trial – new apprenticeship occupations are often introduced as training trials; only after successful evaluation can these be transferred to a regular apprenticeship

Fifty-five current apprenticeship occupations were assessed as relevant for this status quo analysis, with discontinuing apprenticeship occupations also listed (compare Table 5). This list also includes apprenticeship occupations, which, although not directly related to the construction sector, have nevertheless been identified as potential professionals for the sustainable building sector (for example, metal technology, mechatronics, electronics, et cetera).

What is striking about the list is that there is a highly dynamic change in the landscape of apprenticeship occupations, which indicates an updating of outdated occupational profiles and a trend to specialization. For example, the occupation "Bricklayer" is being replaced by the newly introduced apprenticeships "Building construction" and "Building construction specialist" with a focus on new construction or renovation (provisionally as training trials). The apprenticeship occupation "Real estate agent" has also been further differentiated. In addition, there have been numerous updates to occupational profiles, for example, in the occupations "Roofer", "Plumber", and "Plasterer and drywaller".

Overall, there is a slightly positive dynamic in apprenticeships in the selected occupations. Here, the number of apprentices in the selected relevant apprenticeship occupations has increased from 38,782 to 40,733 (period 2015–2021). However, the number of female apprentices in the selected occupations is at a particularly low level of 9%, which is significantly lower than the proportion of female apprentices in the overall apprenticeship system. Only in the planning and administration-related occupations is there a disproportionately high share of female apprentices.

5.2.1 Intermediate and higher-level vocational schools

In addition to the system of apprenticeship training, there is also a highly differentiated full-time school-based VET[36] program at secondary level. Here, a distinction can first be made between schools for intermediate vocational education (Berufsbildende mittlere Schulen, BMS) and colleges for higher vocational education (Berufsbildende höhere Schulen, BHS). These two areas are each further differentiated into various training fields (for example,

[36] Vocational education and training

commerce, tourism, fashion, and business management). Relevant training courses in the construction sector can be assigned to the technical/commercial training sector.

Intermediate vocational schools (BMS) with a duration of between three and four years provide a sound vocational qualification. A BMS can be attended after completion of the eighth grade (in some cases, an entrance examination is necessary). There are currently 28 different curricula (= training courses) in the technical/commercial field[37], of which four courses are related to the construction industry. The curricula are implemented in the form of laws. In all these trainings, compulsory internships of at least four weeks must be completed, as well as the subject of company practice of 20 semester hours per week (this corresponds to about 10–12 calendar weeks) in the form of practical work in a company environment. All qualifications from an intermediate vocational school are classified at NQF level 4.

Colleges for higher vocational education (BHS) last a total of five years and conclude with a diploma and matriculation examination. The diploma examination refers to a higher vocational qualification. The matriculation examination allows general access to higher education. Currently, there are 34 different curricula (= training courses) in the technical/commercial field[38]. Of these, five curricula are related to the relevant field of construction. In total, students must complete at least eight weeks of compulsory work experience. The higher-level vocational school diplomas are assigned to NQF level 5.

In the case of the higher federal technical colleges (Höhere technische Lehranstalt – HTL), there is also a type of school for employed persons, which is aimed at adults (at least 17 years of age) and employed persons with previous vocational training. The main difference is the flexibility of the timetable in the form of semesters and modules (duration: between four and eight semesters). Furthermore, the teaching is more strongly oriented towards adult pedagogical criteria (Mayerl, et alii, 2021). The degree is equivalent to a "regular" BHS degree with a diploma and matriculation examination. In the technical/commercial field, there are also colleges for professionals, which target persons with a general matriculation examination (graduation from a general education school). There are 18 different training courses in total for colleges in the technical/commercial field. Of these, five relate to the construction sector.

In addition, there are industrial master colleges, building craftsperson and master craftsperson schools (Meisterschule, Werkmeisterschule and Bauhandwerkerschule). These last between two and four semesters and are aimed at working people who have completed vocational training (for example, apprenticeship-leave exam or skilled worker exam) in the technical/trade sector. The aim of this type of school is to broaden theoretical specialist training. It is also accompanied by an authorization to train apprentices. For the construction sector, the building craftsperson and master craftsperson schools are particularly relevant[39].

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[37] Federal Law Gazette. II No. 240/2016 as amended – Curricula of technical, industrial and arts and crafts colleges 2016
[38] Federal Law Gazette. II No. 262/2015 as amended – Curricula of the higher federal technical colleges including the arts and crafts training colleges 2015
[39] BGBl. II No. 256/2008 as amended – Industrial master schools (for employed persons); BGBl. II No. 368/2022 as amended - Building trade schools for employed persons 2022

Table 6: Overview of intermediate and higher-level vocational schools

Form of training	Training focus	Duration	NQF level	Implementation curricula	Number of schools
Vocational school	Construction technology	3.5 years 4 years (focus: structural engineering technology, civil engineering technology, structural timber engineering)	4	2016	9
Vocational school	Electrical engineering	3.5 years 4 years	4	2016	12
Vocational school	Building services engineering	3.5 years 4 years (service technology)	4	2016	1
Vocational school	Mechanical engineering	3.5 years 4 years (focus: production engineering, toolmaking, automation engineering, metal construction, automotive engineering, plant engineering)	4	2016	17
Secondary school	Construction technology	5 years	5	2015	14
Secondary school	Electrical engineering	5 years	5	2015	21
Secondary school	Building services engineering	5 years	5	2015	5
Secondary school	Interior design and wood technologies	5 years	5	2015	12
Secondary school	Mechanical engineering	5 years	5	2015	28
Post-secondary VET courses	Construction technology	4 semesters (2 years) 6 semesters (3 years)	5	2022	9
Post-secondary VET courses	Electrical engineering	4 semesters (2 years) 6 semesters (3 years)	5	2022	3
Post-secondary VET courses	Renewable energy, environment and sustainability	4 semesters (2 years) 6 semesters (3 years)	5	2022	-[1]
Post-secondary VET courses	Building services engineering	4 semesters (2 years) 6 semesters (3 years)	5	2022	0
Post-secondary VET courses	Interior design and wood technology	4 semesters (2 years) 6 semesters (3 years)	5	2022	3

Form of training	Training focus	Duration	NQF level	Implementation curricula	Number of schools
Industrial master school	Construction	4 semesters (2 years)	(5)*	2008	12
Industrial master school	Electrical engineering	4 semesters (2 years)	(5)*	2008	21
Industrial master school	Installation and building services engineering	4 semesters (2 years)	(5)*	2008	1
Building craftsperson school	Construction	6 semesters (3 years)	(5)*	2022	4[2]
Building craftsperson school	Wood construction technology	6 semesters (3 years)	(5)*	2022	3[2]
Building craftsperson school	Stone technology and stone design	6 semesters (3 years)	(5)*	2022	1[2]

Source: Own representation

* According to the NQF Qualifications Register, only master craftsperson training has been assigned to level 6 to date. No assessment is yet available for the industrial master and building craftsperson schools. The allocation made here is based on our own assessment. The number of schools was retrieved from the ABC School Finder (https://www.abc.berufsbildendeschulen.at, retrieved on 21.12.2022).

[1] No entries available in the ABC School Finder database

[2] New curricula were introduced at construction trade schools in 2022. The currently listed schools refer to the old curricula (construction – bricklayers, wood construction technology – carpenters, stone technology and stone design – stonemasons).

Financing and control

Vocational schools and colleges are generally federal schools, but their teachers (federal teachers) are administered by the respective provincial education directorates. On the other hand, educational institutions of interest groups are responsible for the industrial master colleges (for example, WIFI, BFI, BAUAkademien). Building craftsperson schools, in turn, are located at vocational schools and colleges.

The training content is defined by the respective curricula, which in each case form the basis for pedagogical actions of the respective teachers. Current curricula are composed of the timetable (by semester and subject matter), the statement of the qualification profile (areas of application, job-related learning outcomes), educational and teaching tasks, and the subject matter. The process of curriculum development is the responsibility of the respective competent departments of the Ministry of Education (the process is described in Markowitsch & Hefler, 2018). The initiative to change curriculum content usually comes from the Ministry itself, but schools or employer-related interest groups can also provide the impetus for revision. Subsequently, a curriculum commission is formed, in which representatives of the respective departments and vocational secondary and higher schools teachers are represented. In addition, other stakeholders (usually social partnership organizations) can participate informally and voluntarily in the development process.

School forms with reference to the building sector

Table 7: Number of students in selected types of schools, school year 2021/22

School type	Training focus	Number of students	Of which are in schools for the employed	Proportion of students in employment
Vocational schools	**Total**	**5,550**	**53**	**1%**
	Construction technology	617	-	-
	Electronics/Computer engineering	747	-	-
	Electrical engineering	938	-	-
	Building services engineering	5	-	-
	Glass technology	99	-	-
	Information technology	1,179	-	-
	Ceramics and stove	52	-	-
	Mechatronics	766	53	7%
	Mechanical engineering	1,147	-	-
Building craftsperson schools	**Total**	**717**	**67**	**9%**
	Construction[1]	31	31	100%
	Electronics/Computer engineering	30	30	100%
	Electrical engineering	387	-	-
	Building services engineering	15	-	-
	Glass technology	6	6	100%
	Information technology	248	-	-
Industrial master schools	**Total**	**2,477**	**2,477**	**100%**
	Construction	336	336	100%
	Electrical engineering	732	732	100%
	Wood technology	36	36	100%
	Installation and building services engineering	55	55	100%
	Mechatronics	181	181	100%
	Mechanical engineering	1,137	1,137	100%
Add-on courses	**Total**	**2,956**	**2,956**	**100%**
	Construction technology	583	583	100%
	Electronics/Computer engineering	213	213	100%
	Electrical engineering	555	555	100%
	Renewable energy, environment and sustainability	98	98	100%
	Building services engineering	83	83	100%
	Interior design and wood technology	63	63	100%
	Mechatronics	119	119	100%
	Furnace construction	22	22	100%
	Mechanical engineering	1,220	1,220	100%
	Total	**943**	**943**	**100%**

School type	Training focus	Number of students	Of which are in schools for the employed	Proportion of students in employment
Post-secondary VET courses	Construction technology	241	241	100%
	Electronics/Computer engineering	105	105	100%
	Electrical engineering	116	116	100%
	Renewable energy, environment and sustainability	18	18	100%
	Building services engineering	34	34	100%
	Interior design and wood technology	193	193	100%
	Mechatronics	17	17	100%
	Furnace construction	6	6	100%
	Mechanical engineering	213	213	100%
Post-secondary VET course/Add-on course	**Total**	**121**	**76**	**63%**
	Construction technology	86	76	88%
	Energy technology, environment and sustainability	35	-	-
Secondary schools	**Total**	**30,634**	**13**	**0%**
	Construction technology	5,580	-	-
	Electronics/Computer engineering	4,230	13	0%
	Electrical engineering	3,987	-	-
	Building services engineering	542	-	-
	Information technology	4,277	-	-
	Interior design and wood technology	1,420	-	-
	Mechatronics	4,178	-	-
	Mechanical engineering	6,420	-	-
Total	-	**43,398**	**6,585**	**15%**

Source: Statistics Austria, School Statistics 2021/22. Special analysis requested. Own calculations.
[1] New curricula.

Students at higher federal technical colleges (HTL) are the main form of education in the vocational school system, according to the selected fields of study. Seventy-one percent of students are enrolled at a higher vocational school, and the relevant field of construction technology is particularly well represented. The number of students enrolled in add-on courses and post-secondary VET courses (which also offer diploma and matriculation examinations) is significantly lower, although all of these courses are offered in the vocational form.

The second largest number of students attend technical colleges, although the relevant field of construction engineering is not as well represented. The industrial master school (Werkmeisterschule) is also a popular type of school, where the mechanical and electrical engineering fields have significantly more students than the civil engineering field. The Werkmeisterschule is also run as a vocational school.

Relevant construction trade schools have the lowest overall attendance, with few school-based offerings available here.

Detailed statistics by gender are not available for the relevant fields of education. However, it can be assumed that the student figures by gender at a more general level also apply to relevant fields. According to the Education in Figures 2020/21 statistics, there is a particularly low proportion of female students in the training forms of technical-commercial colleges (11%), industrial master schools (4%) and higher technical-commercial schools (17%). Only in the post-secondary VET courses is there a balanced ratio of female students (48% female).

5.2.2 Tertiary education

This chapter gives a general overview of the tertiary education landscape in Austria and examines it in more detail in the context of the target groups relevant to the building sector.

Tertiary education system in Austria

The tertiary sector of the Austrian education system is based on a completed secondary education. As a rule, public and private universities and universities of applied sciences offer three-year Bachelor's degree programs, followed by two-year Master's degree programs, for those who have passed the matriculation exam (Matura), the vocational matriculation examination (Berufsreifeprüfung) or the university entrance exam (Studienberechtigungsprüfung).[40] Both institutions also offer diploma programs lasting four to six years. After completing a Master's or diploma program, students have the opportunity to obtain a doctorate or PhD with a study duration of at least three years at the university. The habilitation as the granting of the authorization to teach (venia docendi) is considered the formally highest educational qualification.

Bachelor's degree programs are assigned to National Qualifications Framework (NQF) 6, Master's and diploma degree programs to NQF 7, and doctoral degree programs to NQF 8.[41] Classification 6–8 coincides with the International Standard Classification in Education (ISCED), which serves as an instrument of statistics for the international comparison of educational qualifications[42]. Within the framework of ISCED, occupational fields are defined in addition to educational systems. At the national level, the Austrian Classification of Economic Activities (ÖNACE) should be mentioned in this context, which presents economic sectors and branches in summarized form for statistical purposes.

The ECTS tool (European Credit Transfer and Accumulation System) is used to record students' achievements in order to ensure international readability, comparability, creditability and consequently student mobility within Europe. ECTS points are calculated based on the average time and workload that students need to complete individual learning activities (courses, internships, self-study, exam preparation, theses and exams), which are checked by

[40] At universities and universities of applied sciences, deviations are possible with regard to the minimum duration of study for Bachelor's and Master's degree programs.
[41] https://www.qualifikationsregister.at/nqr-register/nqr-zuordnungen/, retrieved on 20.12.2022
[42] https://www.bildungssystem.at/isced-klassifikation/internationale-standardklassifikation-im-bildungswesen, retrieved on 07.02.2023

performance assessments. In Austria, one ECTS point means 25 real hours of 60 minutes of actual work by a student[43]. A Bachelor's program in Austria requires 180–240 ECTS points and a Master's program 90–120 ECTS points. In any case, the Bachelor's and Master's degrees require 300 ECTS points in total. The required ECTS points within a doctoral program are determined by the universities themselves[44]. The minimum study performance applicable in Austria stipulates that 16 ECTS points must be earned in a Bachelor's or diploma degree program by the end of the fourth semester. Failure to do so will result in the lapse and a two-year block on enrolled studies at the respective university[45].

Upon completion of named studies, academic degrees are awarded, which are determined by the universities and universities of applied sciences. The following list of academic degrees provides an example of possible academic degrees awarded upon completion of named courses of study:

- **Bachelor's degrees**
  - Bachelor of Arts (BA or B.A.)
  - Bachelor of Engineering (BEng or B.Eng.)
  - Bachelor of Science (BSc *or* B.Sc.)
- **Master's and diploma degrees**
  - Diplom-Ingenieur/Diplom-Ingenieurin (Dipl.-Ing., DI or Dipl.-Ing.)
  - Diplom-Tierarzt/Diplom-Tierärztin (Mag. med. vet.)
  - Doctor/Doctor of all medicine (Dr. med. univ.)
  - Doctor/Doctor of Dentistry (Dr. med. dent.)
  - Magister/Magistra of Natural Sciences (Mag. rer. nat.)
  - Magister/Magistra of Philosophy (Mag. phil.)
  - Magister/Magistra of Laws (Mag. iur.)
  - Master of Advanced International Studies (M.A.I.S)
  - Master of Arts (MA or M.A.)
  - Master of Laws (LLM or LL.M.)
  - Master of Science (MSc or M.Sc.(
- **Doctoral and PhD degrees**
  - Doctor of Philosophy (PhD)
  - Doctor/Doctor of Natural Resources and Applied Life Sciences (Dr. nat. techn.)
  - Doctor/Doctor of Technical Sciences (Dr. techn.)
  - Doctor/Doctor of Medical Science (Dr. scient. med.)
  - Doctor/PhD in Montanistic Sciences (Dr. mont.)
  - Doctor/Doctor of Natural Sciences (Dr. rer. nat.)
  - Doctor/Doctor of Philosophy (Dr. phil.)

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[43] https://www.bmbwf.gv.at/Themen/HS-Uni/Studium/Anerkennung/ECTS-System.html, retrieved on 20.12.2022; note: ECTS points show differences in terms of their calculation in international comparison
[44] https://www.bmbwf.gv.at/Themen/HS-Uni/Studium.html, retrieved on 20.12.2022
[45] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulsystem/Gesetzliche-Grundlagen/UG-Novelle-2021-faq/Fragen-und-Antworten-Studierende.html, retrieved on 13.01.2023

- Doctor/Doctor of Laws (Dr. iur.)
- Doctor/PhD in Social and Economic Sciences (Dr. rer. soc. oec.)
- Doctor/Doctor of Theology (Dr. theol.)[46]

Austria has 22 public universities, 17 private universities, 21 universities of applied sciences, 1 private university, 9 public universities of teacher education and 5 private universities of teacher education.

Table 8: Universities and university colleges in Austria

Nr.	Universities	Private universities	Universities of applied sciences	University colleges of teacher education	Private university colleges of teacher education
1	University of Vienna	Anton Bruckner Private University	University of Applied Sciences bfi Vienna GmbH	University College of Teacher Education Carinthia	Private University College of Teacher Education Burgenland
2	Graz University	Bertha von Suttner Private University	University of Applied Sciences Technikum Wien	University College of Teacher Education Lower Austria	Private University College of Teacher Education Augustinum
3	University of Innsbruck	Central European University Private University	University of Applied Sciences Campus Vienna	University College of Teacher Education Upper Austria	Private University of Education, Diocese of Linz
4	Salzburg University	Charlotte Fresenius Private University	University of Applied Sciences Vorarlberg GmbH	University College of Teacher Education Salzburg	Church College of Education – Edith Stein
5	Johannes Kepler University Linz	Danube Private University	Carinthia University of Applied Sciences	University College of Teacher Education Styria	University College of Christian Churches for Teacher Education Vienna/Krems
6	University of Klagenfurt	Gustav Mahler Private University of Music	University of Applied Sciences Wiener Neustadt GmbH	University College of Teacher Education Tyrol	
7	Medical University of Vienna	JAM MUSIC LAB Private University for Jazz and Popular Music Vienna	University of Applied Sciences Sankt Pölten GmbH	University College of Teacher Education Vorarlberg	
8	Medical University of Graz	Karl Landsteiner Private University for Health Sciences	IMC University of Applied Sciences Krems GmbH	Pädagogische Hochschule Wien	
9	Innsbruck Medical University	Catholic Private University Linz	Salzburg University of Applied Sciences GmbH	Hochschule für Agrar- und Umweltpädagogik	

[46] https://www.bmbwf.gv.at/Themen/HS-Uni/Studium/Anerkennung/Akademische-Grade.html, retrieved on 20.12.2022

10	Vienna University of Technology	Music and Art Private University of the City of Vienna	University of Applied Sciences Kufstein Tirol Bildungs GmbH		
11	Graz University of Technology	MODUL University Vienna Private University	CAMPUS 02 University of Applied Sciences GmbH		
12	University of Leoben	New Design University Private University Sankt Pölten	Joanneum University of Applied Sciences GmbH		
13	University of Natural Resources and Applied Life Sciences Vienna	Paracelsus Medical Private University	University of Applied Sciences Upper Austria Studienbetriebs GmbH		
14	University of Veterinary Medicine Vienna	Private University Seeburg Castle	University of Applied Sciences Burgenland GmbH		
15	Vienna University of Economics and Business	Sigmund Freud Private University	MCI Management Center Innsbruck - International University of Applied Sciences GmbH		
16	University of Applied Arts Vienna	UMIT TIROL – Private University for Health Sciences and Technology	University of Applied Sciences Business and Research Institutions of the Viennese Economy GmbH (FHW GmbH)		
17	University of Music and Performing Arts Vienna	Webster Vienna Private University	Lauder Business School		
18	University for Continuing Education Krems	Stella Vorarlberg Private University of Music	Centre for Health Professions Tyrol GmbH		
19	University Mozarteum Salzburg		Ferdinand Porsche Distance Learning University GmbH		
20	University of Music and Performing Arts Graz		Federal Ministry of Defense (maintainer of the degree program "Military Leadership")		
21	University of Art and Industrial Design Linz		Health Professions Upper Austria GmbH		
22	Academy of Fine Arts Vienna				

Source: Own representation

Financing of the higher education system

Public universities in Austria are predominantly financed by public funds. Within the framework of performance agreements, universities undertake to pursue objectives that are mostly set by the Federal Ministry of Education, Science and Research (Bundesministerium für Bildung, Wissenschaft und Forschung – BMBWF) and concretized in negotiations with the universities on certain indicators/target values. The basis for this is the financing system "University Financing New", which was introduced with the new version of the Universities Act in spring 2018. As part of this, the BMBWF has committed to five impact targets, which include more education degrees in the tertiary education sector, competitiveness in research and teaching, and a high level of cutting-edge research. The fulfillment of the target values proves to be an essential indicator for the allocated budget volume[47].

Universities of applied sciences (Fachhochschule – FH), which are considered a relatively young and rapidly developing higher education sector compared to public universities, are financed by the federal government in Austria[48]. The Development and Financing Plan for Universities of applied sciences published by the Ministry of Economy has proven to be a strategic planning document of the federal government for the further development of the UAS sector. It describes quantitative and qualitative objectives as well as financial framework conditions of the federal government for the period 2018/19 to 2022/23 for further expansion steps of the universities of applied sciences[49].

Private universities and private university colleges cannot be financed by the federal government. They are financed mainly from funds of their operators and owners. The legal basis is the Private Universities Act (Privathochschulgesetz – PrivHG) introduced in 1999, which stipulates, among other things, the accreditation requirement of a legal entity based in Austria. The private higher education sector is permitted to participate in competitive research programs and apply for advertised public research funds. The private universities and private higher education institutions themselves are responsible for determining admission requirements[50].

Public university colleges of teacher education are institutions of the federal government and are financed by public funds. They are all subordinate to the Federal Ministry of Education, Science and Research (BMBWF), with the exception of the University of Agricultural and Environmental Education, which operates under the Federal Ministry of Agriculture, Forestry, Regions and Water Management (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft – BML). Curricular matters, however, are also attributed to the BMBWF. In

[47] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulgovernance/Steuerungsinstrumente/Universitätsfinanzierung.html, retrieved on 20.12.2022
[48] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulsystem/Fachhochschulen.html, retrieved on 20.12.2022
[49] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulgovernance/Steuerungsinstrumente/FH-Entwicklungsplan.html, retrieved on 20.12.2022
[50] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulsystem/Privatuniversitäten.html, retrieved on 20.12.2022

order to conclude its own legal transactions, a university of teacher education under public law has its own legal personality[51].

Private universities of teacher education in Austria have a legal entity other than the federal government as their sponsor (for example, a diocese of the Catholic Church, a foundation, et cetera). They require state recognition in accordance with the Higher Education Act (Hochschulgesetz – HG), are responsible in particular for the initial, further and continuing training of teachers and, against the background of the educational mandate under public law, contribute to the impact objectives of the BMBWF[52].

The necessity and extent of tuition fees in Austria depend on the respective university, citizenship, and duration of studies. At public universities, with the exception of the University for Continuing Education Krems (see Chapter 5.3.1), as well as universities of teacher education, the tuition fee is 363.36 euros if the standard period of study is exceeded by more than two tolerance semesters. For regular students from third countries who have a residence permit for students according to the Settlement and Residence Act, the tuition fee is 726.72 euros per semester. Extraordinary students who can only enroll to individual courses and do not pursue a regular course of study are required to pay a tuition fee of 363.36 euros, regardless of their citizenship. Students who are enrolled in more than one course of study, or who are enrolled at more than one university in the course of their studies, have to pay the tuition fee only once. In contrast to public universities, public universities of applied sciences are free to decide whether to charge students a tuition fee of a maximum of 363.36 euros. Only students from third countries who do not have a close relationship to Austria, but who have a residence permit for students, may be required to pay tuition fees that cover the costs at most. Private universities and universities of applied sciences are not subject to any restrictions on the amount of tuition fees and may set them individually[53].

Quality assurance in higher education

Quality assurance in higher education supports the achievement of the institutions' goals and promotes transparency and trust in their importance and quality. In this context, a distinction must be made between internal quality assurance, which refers to the establishment of internal quality management systems at higher education institutions, and external quality assurance, which evaluates the effectiveness of internal quality assurance processes by independent experts. External quality assurance pursues the goals of promoting quality development at universities and providing evidence to the public. Consequently, quality assurance processes are made publicly available. The legal basis for external quality assurance at public and private universities and universities of applied sciences is the Higher Education Quality Assurance Act (Hochschul-Qualitätssicherungsgesetz – HS-QSG). It differentiates between two external quality assurance procedures: the accreditation

[51] https://www.bmbwf.gv.at/Themen/schule/fpp/ph.html, retrieved on 20.12.2022
[52] https://www.bmbwf.gv.at/Themen/schule/fpp/ph.html, retrieved on 20.12.2022
[53] https://www.bmbwf.gv.at/Themen/HS-Uni/Studium/Studienbeiträge.html, retrieved on 20.12.2022

procedure and certification through an audit. Due to their different objectives, they also have different areas of review[54].

Within the framework of an accreditation procedure, higher education institutions or study programs are reviewed based on specified standards and the (temporary) granting of rights to operate a higher education institution or to implement higher education study programs. A distinction is made between institutional accreditation procedures and program accreditation procedures, which, if positive, lead to state recognition of a higher education institution and/or a study program. Accreditation procedures are essential for private universities and their study programs as well as for the new establishment of universities of applied sciences and their study programs[55].

An audit is a cyclical peer review process designed to assess the performance of the institutional quality management system of a university. In this respect, certification through an audit confirms the performance of the internal quality management system of the respective university. Public universities and established universities of applied sciences have to undergo such audits by external experts[56].

In Austria, AQ Austria is an independent body responsible for external quality assurance (conducting accreditation procedures and audits) in the higher education sector. In addition to AQ Austria, other internationally recognized independent agencies, such as those registered in the European Quality Assurance Register for Higher Education (EQAR), are permitted to conduct audits. At the European level, the European Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) form the reference framework for the Austrian higher education quality assurance system[57].

Tertiary education for the building sector

After this general description of the tertiary education sector in Austria, the next step is to focus on the relevant target group, the building sector. In this context, significant higher education institutions and the development of degrees and competences, which are taken into account in current educational offers, have to be pointed out.

For the building sector, only universities and universities of applied sciences are relevant institutions for surveying the status quo of educational offerings in the tertiary education sector. Accordingly, a study by Statistics Austria (2023b) shows that in the 2020/21 academic year, 9,283 of a total of 59,993 regular graduates completed their Bachelor's, Master's, diploma or doctoral degree (NQF 6–8) at a public or private university or university of applied sciences in Austria. 6,459 of the graduates of the classified field of education "Engineering, manufacturing and construction" (assignable to the ÖNACE 2008 classification of economic

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[54] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulsystem/Akkreditierung-Qualititätssicherung.html, retrieved 02.02.2023
[55] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulsystem/Akkreditierung-Qualititätssicherung.html, retrieved 02.02.2023
[56] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulsystem/Akkreditierung-Qualititätssicherung.html, (retrieved 02.02.2023
[57] https://www.bmbwf.gv.at/Themen/HS-Uni/Hochschulsystem/Akkreditierung-Qualititätssicherung.html, retrieved on 02.02.2023

activities, code 7, Construction) were men and 2,824 were women. Consequently, 15.47% of all graduates chose this field of education, which ranks second in terms of the number of graduates. In addition, the field of "Business, administration and law" ranked first with a percentage of 22.28 and the field of "Education" ranked third with a percentage of 14.38. The proportion of women in the field of "Engineering, manufacturing and construction" was 30.42% in the academic year 2020/21.

Based on the same data breakdown from the 2010/11 academic year, it can be seen that the number of general degrees in Austria about ten years ago was 45,806 students and consequently increased by 30.97%. For the education field "Engineering, manufacturing and construction" an increase of 45.48% can be noted with a graduation number of 6,381. Whereas this field of education is currently in second place in terms of the number of graduates, about ten years ago it was in third place with 13.93%. At that time, the field of "Economics, administration and law" was in first place with a percentage of 22.98 and the field of "Social sciences, journalism and information" was in second place with a percentage of 14.69. The percentage of women in the field of "Engineering, manufacturing and construction" was 24.52% about ten years ago, which means that an increase of 24.06% can be noted.

5.2.3 Professional authorization

Closely linked to formal education is a credentialing system. On the one hand, credentials associated with an educational and professional qualification enable the connection of further relevant educational pathways. On the other hand, credentials are linked to specific trade licenses. In the following, the most important authorizations will be presented specifically with regard to the construction industry. Professional access to the construction industry is defined by the Trade Regulation Act (Bundesinnung Bau, 2022). In addition to the regulated credential "Baumeister" (master builder), there is also the possibility of a practice of partial trades (Baugewerbetreibende; building tradesmen). In addition, training courses provide access to employment categories (for example, construction manager) in accordance with the collective agreements for blue and white-collar workers.

- **Dual training**: The final apprenticeship examination entitles the holder to perform skilled work in the learned occupation. Together with a defined practical experience and an entrepreneurial examination, access for construction tradesmen can be obtained.
- **School for intermediate vocational education (BMS):** Individuals who have graduated from an intermediate vocational school can subsequently complete an add-on course in order to acquire the matriculation and diploma examination. According to a decree of the Federal Ministry of Economy, there is an equivalence with defined apprenticeship occupations.[58] For example, a degree from a vocational school for construction

[58] Decree of the Federal Ministry of Economy, Family and Youth. "Gleichhaltung von schulischen Ausbildungsabschlüsse mit facheinschlägigen Lehrabschlüsse gemäß §34a BAG", BMWFJ-33.800/0005-I/4/2012. In the construction sector, there are approximately the following equivalences: "Bautechnik" (HTL, Fachschule) to the apprenticeships masonry or structural engineering; "Gebäudetechnik" (HTL) to the apprenticeship installation and building services engineering. For more information, see: https://www.wko.at/service/w/bildung-lehre/Erlass-ueber-den-Ersatz-von-Lehrzeiten.html

technology is considered equivalent to an apprenticeship in bricklaying or building construction. Together with a defined practical experience and an entrepreneurial examination, access for building tradesmen can be obtained.

- **College for higher vocational education (BHS):** Persons who have graduated from a college for higher vocational education (including graduates of an add-on course or post-secondary VET course) acquire a diploma and maturity examination, which entitles them to general admission to higher education. According to a decree of the Federal Ministry of Economy, there is an equivalence with defined apprenticeship professions. Together with a defined practical experience access for building craftspersons can be obtained. The entrepreneur examination is omitted. After three years of relevant professional experience resulting in an expansion and specialization of professional competences, the title of engineer can be acquired based on a certification procedure including proof of professional practice and a technical interview (corresponds to NQF 6).
- **Industrial master (Werkmeister):** With the industrial master's degree, a qualification for management at the middle level is acquired. The industrial master certificate entitles the holder to work as a foreman in accordance with the definitions in the collective agreement. According to the career paths, the foreman's training in the construction sector is a possible qualification requirement for the next career level, "site manager".
- **Building craftsperson (Bauhandwerker):** Graduation from a building craftsperson school includes the qualification of a foreman's school and thus entitles the holder to exercise the foreman's function. In addition, the degree includes a contractor's examination and entitles the holder to train apprentices. The degree is a possible prerequisite for the acquisition of the qualification as a construction manager.
- **Engineering office (Ingenieurbüro)**: Engineering offices (consulting engineers) are a regulated trade according to the Industrial Code**.** Engineering offices deal, among other things, with consulting, the preparation of plans, calculations, expert opinions and studies, the execution of investigations and measurements, as well as with the supervision of the execution and acceptance of projects. They can be found in a wide variety of technical and scientific fields of activity (for example, in the fields of electrical and installation engineering, cultural engineering and water management, mechanical engineering and steel construction, interior design, spatial planning and land use planning, landscape planning and landscape architecture, and even surveying).[59] Besides the successful completion of the qualifying examination, the prerequisite for access to the profession is to complete a relevant degree program or at least four semesters of postgraduate studies. At least three years of professional activity in the relevant field, or successful attendance of a relevant intermediate vocational school (BMS) with at least six years of professional activity is also required.[60]

[59] https://www.ingenieurbueros.at/verband/de/das-ingenieurbuero/berufsbild, retrieved on 16.06.2023
[60] https://www.ingenieurbueros.at/verband/de/das-ingenieurbuero/rechtliches/zugangsvoraussetzungsverordnung-und-befaehigungspruefungsord, retrieved on 16.06.2023

- **Master builder (Baumeister):** The trade license for the regulated trade of master builder according to the Trade, Commerce and Industry Regulation Act is acquired through a qualifying examination for master builder. The examination regulations are laid down in a separate ordinance by the Presidium of the Austrian Federal Economic Chambers (with the approval of the Minister of Economy). There is no formally organized training program with a corresponding curriculum. The prerequisite for this is appropriate professional experience. In addition, possible prior qualifications can be credited, which reduces the scope of the examination. Otherwise, access to this qualification examination is open to all persons over the age of 18. The qualification examination is generally classified at NQF 6 level for master craftsperson.
- **Civil engineer (Ziviltechniker):** Civil engineers work as architects or engineering consultants on a freelance basis in about sixty different engineering or scientific fields. The authority to do so is granted by the Federal Ministry of Economy and Labor under the Civil Technician Act (Ziviltechnikergesetz, ZTG). The prerequisite for the award of the license is proof of the professional qualification required for the exercise of the profession through
  - Completion of a relevant engineering or science degree,
  - At least three years of practical experience after graduation,
  - Passing of the civil engineer examination.

  The designation of authority is based on the particular degree completed[61].

5.3 Continuing education system

Organized continuing education, or the non-formal education sector, is a notably heterogeneous field whose historically evolved structures show great diversity. They are supported by non-profit and state or public law institutions and, since the 1980s, increasingly by profit-oriented and in-house institutions. Overall, organized continuing education is characterized by a lower degree of legalization and public regulation, as well as legal and financial security, compared to the formal education sector of schools and universities. Forms of influence range from legal embedding of continuing education in the education system to almost complete non-regulation. This allows the continuing education sector to respond particularly flexibly to changing societal challenges and emerging educational needs. However, the continuing education landscape with its diverse provider organizations and offerings is often perceived as confusing.

For structuring purposes, the model of reproduction contexts of continuing education according to Schrader is taken up in the following (Schrader, 2010). The model is based on neo-institutionalist research and social science theories of modernization. It enables a stringent systematization of continuing education organizations using the question of how continuing education organizations can obtain necessary resources and legitimacy. In this respect, two fundamental, socially institutionalized legitimation possibilities can be distinguished:

[61] https://wien.arching.at/ziviltechnikerinnen/wer_sind_ziviltechnikerinnen.html, retrieved on 07.03.2023

- Organizations may invoke public interests committed to the common good or private interests when exchanging goods or services.
- The securing of resources can either take the form of a contract, as a voluntary, joint declaration of intent by contract partners with equal rights in principle, or take the form of an order under hierarchical conditions.

Based on these basic forms of performance exchange and legitimation, which are significant for the reproduction of organizations, four areas can be distinguished according to Schrader, which can be described as follows with regard to continuing vocational training:

1. Continuing education offered by the state or in the public sector, where social goals are pursued on behalf of the public for a wide range of addressees (for example, academic continuing education at universities of applied sciences and universities, higher technical schools or colleges for professionals, vocational schools, industrial master colleges, building craftsperson and master craftsperson schools);
2. Continuing education programs offered by communities of interest and values that pursue public interests for social groups on a contractual basis (for example, continuing education institutions of chambers, guilds, and professional associations);
3. Commercial training in the area of the market where private interests are pursued on a contractual basis (for example, product suppliers), as well as
4. Continuing education programs in companies where company interests and hierarchical conditions dominate (in-company continuing education).

This makes it possible to systematize the many different players in the field of continuing vocational training in the building construction sector and, at the same time, to show the different logics according to which these organizations design their offerings.

5.3.1 State context: academic continuing education

In the state or public sector, there are continuing education organizations that fulfill a public educational mandate based on continuing education laws and address a wide range of people. The offerings of vocational and technical schools for continuing vocational education and training, which address a rather closed group of addressees, also belong to this area (Schrader, 2010, page 276).

In the present context, offers of the employment service or of national, regional or municipal institutions, where further training is offered within the framework of job offensives or work foundations, can fulfill an educational mission. An example is the environmental foundation of the Aufleb GmbH of the ÖGB and the WKO. It was launched in 2022 by the AMS together with the Federal Ministry of Labor and Economy (Bundesministerium für Arbeit und Wirtschaft – BMAW) and the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie – BMK) in close cooperation with companies in the field of climate

professions[62]. Another example is the initiative "Jobs PLUS Ausbildung" of the Wiener Arbeitnehmer:innen Förderungsfonds (waff; Vienna Employment Promotion Fund), where currently training courses for installation and building services technicians and refrigeration technicians are offered[63].

Also relevant are legally regulated vocational school-based continuing education programs at technical colleges and colleges for professionals as well as at vocational schools, industrial master colleges, building craftsperson and master craftsperson schools. Efforts are also currently being made to give further vocational training more visibility, comparability and recognition on the basis of a legal regulation, thereby making it more attractive. To this end, the draft of the Federal Act on Higher Vocational Education and Training is currently under review. This law should make it possible to create new practical vocational qualifications for skilled workers with an apprenticeship qualification or subject-specific professional experience at qualification levels 5 to 7 of the NQF on a statutory basis. The current draft law also emphasises the consideration of climate protection and sustainability requirements (HBB-G § 3, para. 2 and 4).

The state or public sector also includes continuing education programmes at universities of applied sciences and universities. In the following, a general insight into this scientific continuing education landscape in Austria is given, which is then placed in the context of the target group relevant here, the building sector.

Academic continuing education in Austria

In Austria, there is no uniform definition of the term "academic continuing education"; there is also a certain diversity in the terms used. Thus, terms such as "university continuing education" and "scientific continuing education" can be found in Austrian usage. Gornik (2019) has addressed this issue and, in a comprehensive understanding of continuing education in science, has noted factors such as the research reference, the academically pre-educated target group to be reached externally, the postgraduate focus of offerings, and the implementing scientific institution itself with its scientific claim. In addition, practical relevance was added, which is essential for postgraduate continuing education courses according to Gornik (2019, page 4).

In his definition, Lenz (2005) strongly emphasizes the implementation of scientific educational institutions and means that scientific continuing education refers to educational offers that are developed and implemented by universities or institutions related to them. Accordingly, he refers to the University Act of 2002, which states that the continuing education of university graduates is part of the universities' remit (Lenz, 2005a, page 53–54). According to the University of Applied Sciences Act (Fachhochschulgesetz), universities of applied sciences have been entitled to offer continuing education courses since 2003. According to the Federal Law on the Organization of Universities of Teacher Education and their Studies, the continuing education of teachers is also a central task of universities of teacher education (Gruber & Lenz, 2016, page 105).

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[62] https://www.aufleb.at/umweltstiftung/, retrieved on 05.01.2023
[63] https://www.waff.at/jobs-ausbildung/jobs-mit-ausbildung/technik/, retrieved on 05.01.2023)

According to Gruber and Lenz (2016), higher education in Austria has been very narrowly defined for a long time. Accordingly, academic continuing education long remained limited to the activities of individual academics and was not elevated to a general university self-image. An increased opening of universities did not occur until the 1970s in the course of a general educational reform and expansion (Gruber & Lenz, 2016, page 104). In the meantime, against the backdrop of the aforementioned legal provisions and the increasing need for academic continuing education, university institutions for continuing education have been established at almost all universities and universities of applied sciences. Courses offered there are considered the highest forms of scientific continuing education. Financially, they are self-supporting and development costs are partly financed by public funds and running costs by contributions from participants (Lenz, 2005a, page 56). Depending on scope and reputation, course costs in Austria vary particularly widely and can exceed 20,000 euros (Gruber & Lenz, 2016, page 21).

The names of the responsible continuing education institutions underline the previously mentioned diversity of the understanding of terms around academic continuing education. In this respect, the continuing education institution of the University of Innsbruck calls itself "Coordination Office for University Continuing Education"; the University of Graz, however, chose the terms "Uni for Life" and "Center for Continuing Education". Increasingly, English instead of German terms such as "Life Long Learning" (Graz University of Technology), "Continuing Education Center" (Vienna University of Technology), "Executive Academy" (Vienna University of Economics and Business), "Postgraduate Center" (Vienna University of Technology), and "Postgraduate School" (Medical University of Graz) have become accepted (Gornik, 2019, page 5).

The University of Continuing Education Krems (UWK), which was established in 1994 as one of 22 national universities, is a special case in Austria. Financed through subsidies from the federal and state governments and contributions from participants in the private sector, it offers academic continuing education (Lenz, 2005b, page 56).

Quality assurance in academic continuing education

There are differences in the quality assurance of academic continuing education programs at universities. At public universities (including the University of Continuing Education Krems) and universities of applied sciences, courses are integrated into the university's internal quality assurance and development and are required to have their quality management systems certified in an audit. At universities of applied sciences, continuing education courses must also have the same subject areas as accredited courses at the respective university. At private universities, all courses are required to undergo program accreditation in the case of graduation with an academic degree. At teacher training colleges, the contents of the courses for the further and continuing education of teachers shall be based on the requirements of the competent member of the government or, with the latter's authority, on the regional requirements of the school authority subordinate to the latter. In addition, for colleges of teacher education, a focus on content is established by law (Kulhanek, et alii, 2019, page 98).

Postgraduate courses may differ in terms of content, target groups, admission requirements and degrees. In this context, there are offerings referred to as certificate courses, certificate programs, certificate courses, (university) courses, seminars, and lectures (Gruber & Lenz, 2016, page 105). Graduates of these courses receive a certificate or a job title added by "Akademisch geprüft", that is "academically certified" (Lenz, 2005a, page 56). In addition, there are courses with an academic degree, the legal framework of which was adapted in October 2021 in the course of the reform package for continuing education at universities. Accordingly, the general university entrance qualification and several years of relevant professional experience are the admission requirements for a Bachelor's degree and a completed Bachelor's or diploma degree and several years of relevant professional experience for a Master's degree. Only in exceptional cases defined by law can admission be granted with relevant professional qualifications or several years of relevant professional experience (Lehrgänge, no date). In particular, the introduction of the extraordinary Bachelor's degree, which hardly appears in the current educational landscape, represents an important change in the context of the above-mentioned reform, so that graduates of an extraordinary Master's degree also have access to doctoral or PhD studies[64]. Ultimately, the universities themselves always decide on admission to doctoral or PhD studies.

Postgraduate Bachelor's degrees with a duration of about six semesters are assigned to NQF 6 and postgraduate Master's degrees with a duration of two to four semesters to NQF 7. The duration of studies is set at 180 ECTS accreditation points for Bachelor's degrees and 120 ECTS[65] for Master's degrees. The following academic degrees are legally defined in this context:

- **Bachelor's degrees**
  - Bachelor of Arts (Continuing Education)
  - Bachelor of Science (Continuing Education)
  - Bachelor Professional
- **Master's degrees**
  - Master of Arts (Continuing Education)
  - Master of Science (Continuing Education)
  - Master Professional
  - Master of Business Administration
  - Executive Master of Business Administration
  - Master of Laws[66]

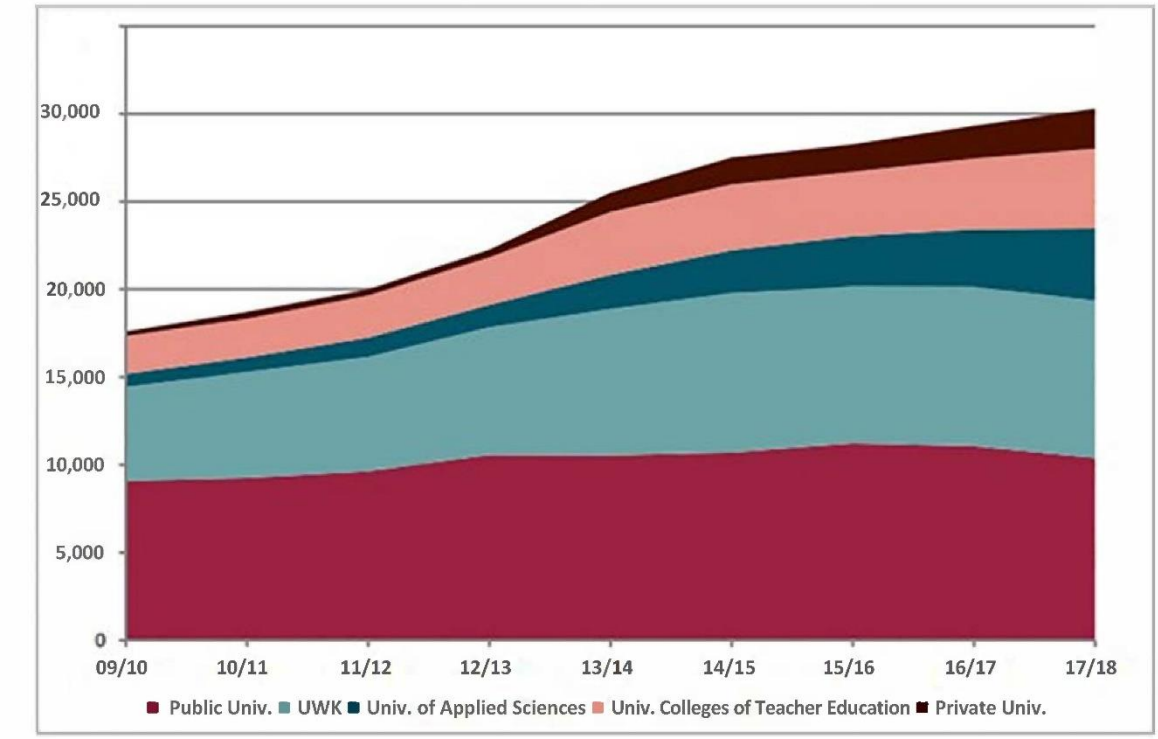
Postgraduate courses such as university certificate courses, seminars and modules, et cetera cannot be clearly assigned to an NQF level. Due to their scientific orientation and the fact that they predominantly address academics with professional experience, an NQF level of 6–8[67] can be assumed. In this context, a study by the institute of advanced studies (IHS) from

[64] https://www.bmbwf.gv.at/Themen/HS-Uni/Studium/Lehrgänge/Reformpaket_Weiterbildung.html, retrieved on 13.01.2023
[65] Minimum 60 ECTS
[66] https://www.bmbwf.gv.at/Themen/HS-Uni/Studium/Lehrgänge.html, retrieved on 10.01.2023
[67] For shorter course offerings, an NQF of 3–5 is also addressed in individual cases.

2019 provides information that at Austrian universities (excluding UWK) a degree is a minimum requirement for 74% of the courses offered and for 53% even a relevant degree. However, in order to address a larger target group, sufficient professional experience can also be proven instead of such formal educational requirements. For 19% of the courses, a matriculation examination and for 8% another educational qualification (for example, completed vocational training, master craftsperson's examination, et cetera) is a prerequisite. In addition, public universities (excluding UWK) insist on a university degree as a prerequisite far more often than universities of applied sciences do (Kulhanek, et alii, 2019, page 34).

With regard to the number of continuing education students, the same study by the IHS reveals an upward trend for the period from 2009/10 to 2017/18. Although an increase in participation in formal academic continuing education programs can be observed, only 6% of students took courses with at least 30 ECTS credits in 2017/18 compared to the total number of students in Austria (Kulhanek, et alii, 2019, page 28).

Figure 9: Participants in university courses with more than 30 ECTS (public universities: also courses with less than 30 ECTS)

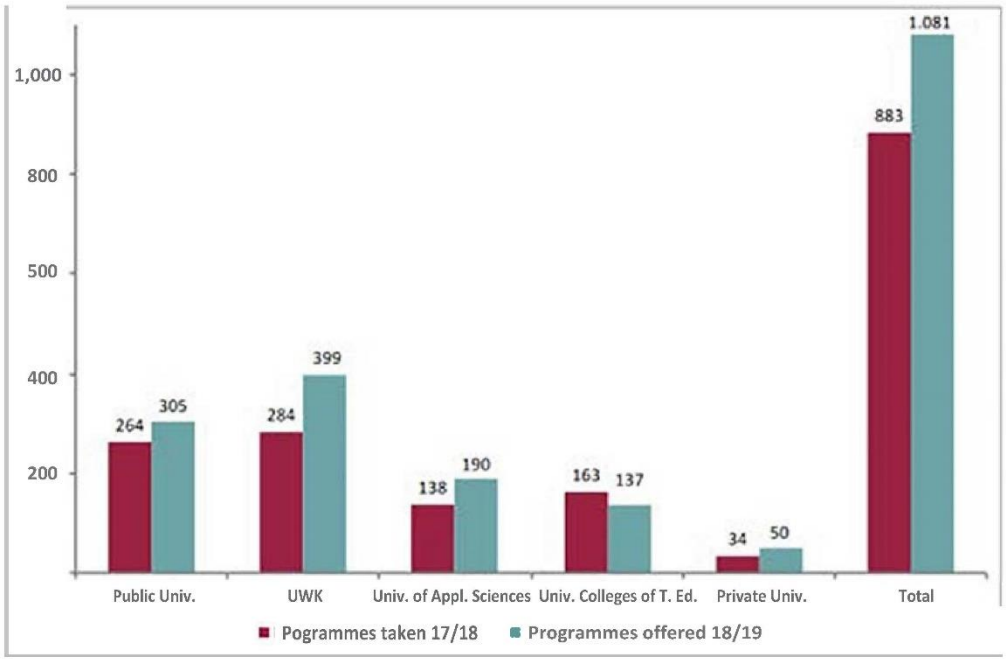


Source: Kulhanek, et alii, (2019, page 28)

Furthermore, it can be seen that continuing education in science is offered in all higher education sectors in Austria: at 21 out of 22 public universities, at 18 out of 21 universities of applied sciences, at all universities of teacher education, and at 9 out of 13 private universities (as of 2019). The University of Continuing Education Krems always plays a special role with its specialization in continuing education courses. Thirty percent of all courses taken in 2017/18 were offered by public universities, 32% by the University of Continuing Education

Krems, 16% by universities of applied sciences, 18% by teacher training colleges, and 14% by private universities (Kulhanek, et alii, 2019, page 20).

Figure 10: Continuing education courses (> 30 ECTS) by higher education sector



Source: Kulhanek, et alii (2019, page 20)

Survey of graduates on continuing education

As far as participation in formal academic continuing education programs in the building sector is concerned, a revealing and exemplary insight was provided by a survey of graduates of Graz University of Technology conducted in 2018 (x-sample, 2018, on behalf of TU Graz) with a view to the service facility Life Long Learning (LLL) of Graz University of Technology, which specializes in scientific continuing education.

The sample of 9,797 graduates of Graz University of Technology who had completed a diploma, Master's or doctoral program between 2000 and 2012 (several years of work experience guaranteed) was characterized by an overrepresentation of graduates with an educational background in architecture and civil engineering (29%). Twenty-two percent had an educational background in the faculties of electrical engineering, information technology, or computer science, 18% in technical mathematics, technical physics, technical chemistry, process engineering, or biotechnology, 16% in mechanical engineering, or economics, and 15% had completed an interfaculty or non-faculty diploma, Master's or doctoral program. Nine percent of the population had an employment relationship with Graz University of Technology and/or were enrolled in a (further) study program, while 91% had no such relationship to this university. Eighty-one percent of the graduates were male and 19% female.

This population of graduates indicated a high degree of affinity for continuing education. According to the survey, 84% of the graduates had taken part in continuing education since

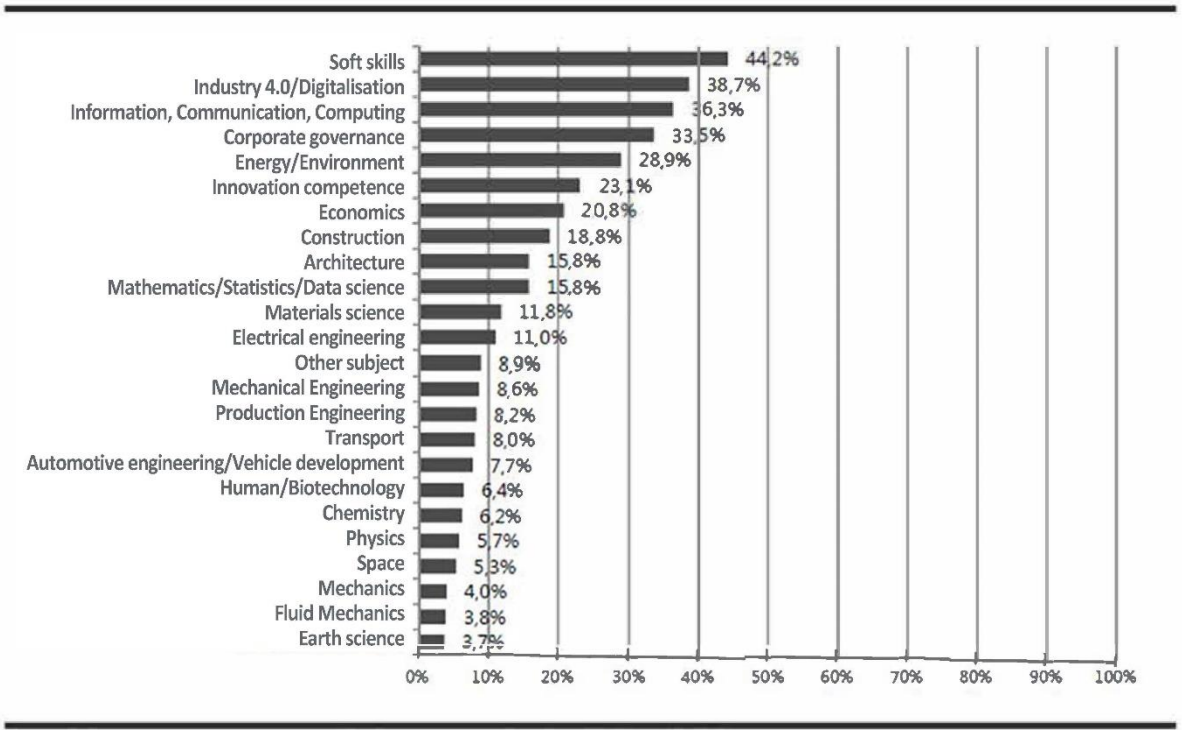
completing their studies. The 16% who had not yet taken advantage of continuing education programs were younger (under 30), had Master's degrees, were self-employed, or were from one-person companies and microenterprises. The low participation of younger persons in continuing education could be related to the fact that they had not graduated long ago. This result therefore suggests that self-employed persons from EPUs and microenterprises are a relevant target group that could be addressed more strongly by creating attractive continuing education offerings.

The market for continuing education was described as large by the TU Graz graduates. Thus, 100 different continuing education providers were named. The most frequently cited providers were WIFI, Graz University of Technology, various internal company training programs, the Civil Engineering Forum (exclusively by graduates with a background in architecture and civil engineering) and BFI.

Graduates named technical and specialized knowledge as the most important qualifications for the future. In this context, people with a background in architecture and construction particularly emphasized the computer-aided planning method Building Information Modeling (BIM) and sustainable and energy-efficient forms of construction. In addition, soft skills were also given a high priority.

Despite the occupation-specific preferences against the background of the respective training, the graduates were most interested in cross-sectional topics that are important in all technical and scientific disciplines. In addition, there was a pronounced interest in personal development and (business) management training courses. Accordingly, the strongest demand for continuing education was in the areas of soft skills, industry 4.0/digitization, information/communication/computing, corporate management, energy/environment, innovation competence and economics.

Figure 11: Relevance of individual topics to continuing education



Source: x-sample (2018) on behalf of TU Graz

Regarding the awareness of the service institution Life Long Learning (LLL) of Graz University of Technology, which was founded in November 2005, 82% of the graduates knew it by name in 2018 and 63% were informed about its offers. The awareness and information values were noteworthy not only for those who recently graduated from Graz University of Technology or who had a close relationship with the university, but also among external graduates who were not employed here or enrolled in a degree program. The need to address older graduates (40 years and older) more intensively could be derived. Approximately 5% of all graduates surveyed had already taken advantage of the LLL service facility (x-sample, 2018).

In this context, it can be shown that since the publication of this survey in March 2018, the general offer of the service facility Life Long Learning (LLL) has almost tripled and thus higher numbers of participants can be assumed. The continuing education content of the computer-aided planning method Building Information Modeling (BIM), which is desired by graduates with an educational background in architecture and construction, has now found its way into the content of various training courses. Demanded sustainability and energy efficiency topics are addressed, for example, in university courses such as "Decarbonization and Sustainability Management", "Moisture and Leakage Monitoring", or "Smart Neighborhood Development in Small and Medium-Sized Cities". Since 2021, offerings of LLL have also expanded to include, among others, the MBAs in "Digital Leadership" and "Green and Digital Transition" as well as the MBA in "Leadership in Digital Transformation", which can be strongly related to the in-demand continuing education topic of "Industry 4.0/Digitization" and "Corporate Management" respectively.

5.3.2 Context communities

The area of communities of interest and values includes those continuing education organizations that pursue public interests for social groups based on concluded contracts. These include, for example, professional pressure groups, which address a (potentially) public with their continuing education offerings, as well as continuing education organizations of professional associations, which pursue the interests of the respective professional group based on voluntary or compulsory memberships in associations, guilds, and chambers and address a rather closed group of addressees. They can either be more state-regulated or more corporatist self-governing (Schrader, 2010, page 275).

With a view to continuing vocational training in the field of energy and resource-efficient construction for a wide range of addressees, two public non-profit vocational training providers supported by the chambers are particularly significant in Austria. These are WIFI (Economic Promotion Institute of the Austrian Federal Economic Chambers) and bfi (Vocational Promotion Institute of the Chambers of Labor and the Austrian Federation of Trade Unions). They offer a wide range of vocational training courses, including specific courses and training programs in the fields of construction or ancillary construction trades.

The WIFI offers, for example, continuing education and personal certification in energy, building technology, and construction/construction trades. This includes Certified photovoltaic technician, Certified solar heat installer, Certified heat pump technician, integral building and energy management, BIM coordinator, BIM practitioner, BIM installer, Integral building and energy management, BIM coordinator or practitioner, courses on CAD, OIB guidelines, Ecological building technology, Energy consulting, Energy performance certificate, Building automation, Smart home systems, Qualified assessment of building renovation, and Facility management. WIFI is also an educational partner of the klima**aktiv** initiative of the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology in the field of sustainable building and heating with renewables.

Examples of bfi courses in the field of technology, ecology, safety are Foreman in building construction, waterproofing and building material science, Installation and building technology, Refrigeration plant technology, AutoCAD. In addition, bfi NÖ (Lower Austria) is currently building the first climate protection-training center in Europe together with the Arbeitsmarktservice (AMS) NÖ in order to meet the increasing demand for labor in the fields of ecology, environmental protection, and energy management. Scheduled for completion in the fall of 2023 it will become a pioneer in training in the areas of renewable energy, environmentally related building technology, and modern, energy-efficient house technology.[68]

The Austrian BAUAkademien (construction academies) of the regional construction guilds, which offer a comprehensive range of training and continuing education programs for construction professions at eight locations in Austria, are also a key player. In addition to the inter-company training of construction apprentices and master craftsperson and master

[68] https://www.ams.at/regionen/niederoesterreich/news/2022/06/ams-und-bfi-noe-errichten-1--klimaschutz-ausbildungszentrum-in-e, retrieved on 11.01.2023

builder schools, a wide range of seminars, courses, and Master's degree programs are offered for professionals and managers in the construction industry[69]. The BAUAkademien offer, for example, more than a hundred courses in the field of construction technology/energy efficiency and a Master's program for BIM. They are also educational partners of the klima**aktiv** initiative of the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology in the field of building standards.

Other relevant actors or offerings for the (further) development of competences to increase energy and resource efficiency in the building sector that could be identified in the context of the present study are, for example,

- ARGE EBA, which provides training for energy consultants on behalf of the federal states or their state energy agencies,
- Austrian Institute of Technology (AIT) with advanced training programs on heat pumps, solar thermal, photovoltaics, comfort ventilation, among others,
- Austrian Institute for Building Biology and Ecology (IBO), a scientific association for ecological architecture with knowledge dissemination on material ecology, building evaluation, building physics,
- Institute for Flat Roof Construction and Building Waterproofing (IFB) with advanced training courses on the construction and maintenance of building envelopes,
- Austrian Sustainable Building Council (Österreichische Gesellschaft für Nachhaltiges Bauen, ÖGNB),
- Federal Association Photovoltaics Austria with corresponding further training offers,
- Immobilienakademie Betriebs-GmbH of the Austrian Association of the Real Estate Industry (Österreichischer Verband für Immobilienwirtschaft, ÖVI) with courses and seminars, for example, on sustainable building renovation and heating exchange,
- TÜV Austria Academy with further training and certification in areas such as construction, building services engineering, refrigeration, air conditioning and ventilation technology, photovoltaics, energy efficiency and climate protection,
- Future Agency for Construction (Zukunftsagentur Bau, ZAB) of the Austrian Association of Master Builders with advanced training courses, for example, on component activation, BIM, and energy efficiency in cooperation with BAUAkademien, or
- zt: akademie of the Chamber of Civil Engineers for Vienna, Lower Austria and Burgenland, with continuing education courses on real estate and sustainability, building-integrated photovoltaics, et cetera.

In Table 23, the researched providers are listed with further information and relevant offers regarding relevant competences for achieving the climate targets in the building sector (see Chapter 5.4).

[69] https://www.bauakademie.at/article/18-die-bauakademien, retrieved on 11.01.2023

5.3.3 Context market: product suppliers

In the area of the market, private interests are pursued with further training offers based on contracts. Here, commercial continuing education organizations and private training institutes are active, which implement educational offers for the Public Employment Service, offer in-house continuing education and address private inquirers (Schrader, 2010, p. 276).

In the present context, with a view to commercial further training in the building construction sector, private institutions that offer specialist further training should be mentioned. These include, for example, the training partners of buildingSMART Austria (bSAT) that provide BIM training (Acht-Engineering, ALLPLAN Austria, A-Null, Artaker, ATS, bimm, Habra, Mensch und Maschine Austria, SIDE Academy, Überbau) and thus contribute to the development of digital skills to support better energy efficiency in buildings.

Private companies that do not primarily implement training offerings, such as product providers, are also relevant in the area of the market, as can be seen from the studies on continuing vocational training in companies (see also Chapter 5.3.4). According to CVTS6, manufacturing companies, suppliers, parent companies or partner companies are overrepresented among course providers of external courses in the construction sector compared to the average of all economic sectors surveyed. Forty-seven percent of companies in the construction sector took advantage of such offers for in-company training – see Figure 1714 (Statistics Austria, 2023a, page 56).

By their very nature, continuing education courses offered by companies whose main purpose is not the implementation of educational offerings, such as product providers, are not accessible via public continuing education platforms and databases.

In Table 23 (see Appendix II), some commercial suppliers, especially for software solutions, are listed with further information and relevant offers regarding relevant competences for the achievement of climate targets in the building sector (see Chapter 5.4).

5.3.4 Context company: continuing education in the workplace

In the context of companies, private interests are pursued under hierarchical conditions with regard to the implementation, participation and design of continuing education. This area includes in-company continuing education, which is aimed at a closed group of addressees, namely the employees of companies. It can be carried out by in-house continuing education departments or by organizations founded by companies for the continuing education of the employees of one or more companies (Schrader, 2010, page 276).

These can also be qualification networks with several companies in a region or sector joining forces to plan and implement customized qualification measures for their workforce. They can be funded by the Public Employment Service (AMS), as in the case of the Impuls-Qualifizierungsverbund (IQV)[70].

[70] https://www.ams.at/unternehmen/personal--und-organisationsentwicklung/impuls-qualifizierungs-verbund-iqv, retrieved on 11.01.2023

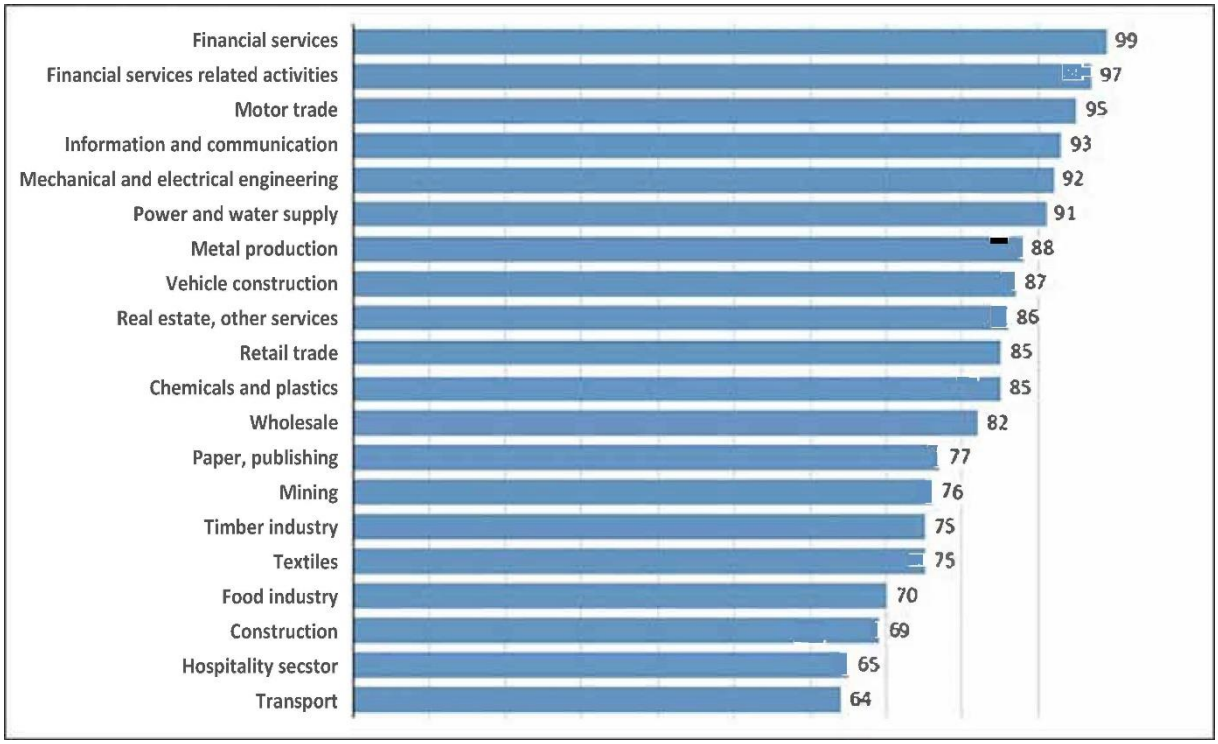
With regard to the question of whether and which companies or further training providers of/for companies or qualification networks are currently carrying out measures for the competence development of their employees specifically in the field of energy and resource efficiency in the building sector, no data surveys are known.

Continuing education in the construction industry

In order to gain an impression of continuing vocational training in Austria's construction sector in general, statistical data can be shown based on the EU-wide harmonized European Continuing Vocational Training Survey (CVTS) conducted regularly every five years by Statistics Austria. The CVTS is a sample survey of enterprises with at least ten employees in the manufacturing and service sectors (NACE sectors B to N and R to S). Continuing vocational training in enterprises is defined as all training activities in which employees participate either in paid working time and/or which are financed in whole or in part by the employees of their enterprise.

In the current sixth survey, the CVTS6, 5,006 Austrian companies were asked about their training activities in 2020. The results showed that 79% of the companies were active in training in 2020. These companies had employees attend courses or other forms of in-company continuing education during paid working hours or paid for continuing education activities in which employees participated outside working hours in whole or in part. The likelihood of a company being active in continuing training increased with the number of employees – for companies with at least 250 employees, the continuing training rate was 98%, while for companies with 10 to 49 employees it was only 76%. In addition, there are major sector-specific differences: while almost all enterprises in the financial services sector (respectively between 97 and 99%) were active in continuing education, and almost all enterprises in the mechanical and electrical engineering sector (92%), construction, at 69%, is one of the sectors with a lower continuing education rate (Statistics Austria, 2023a, page 18).

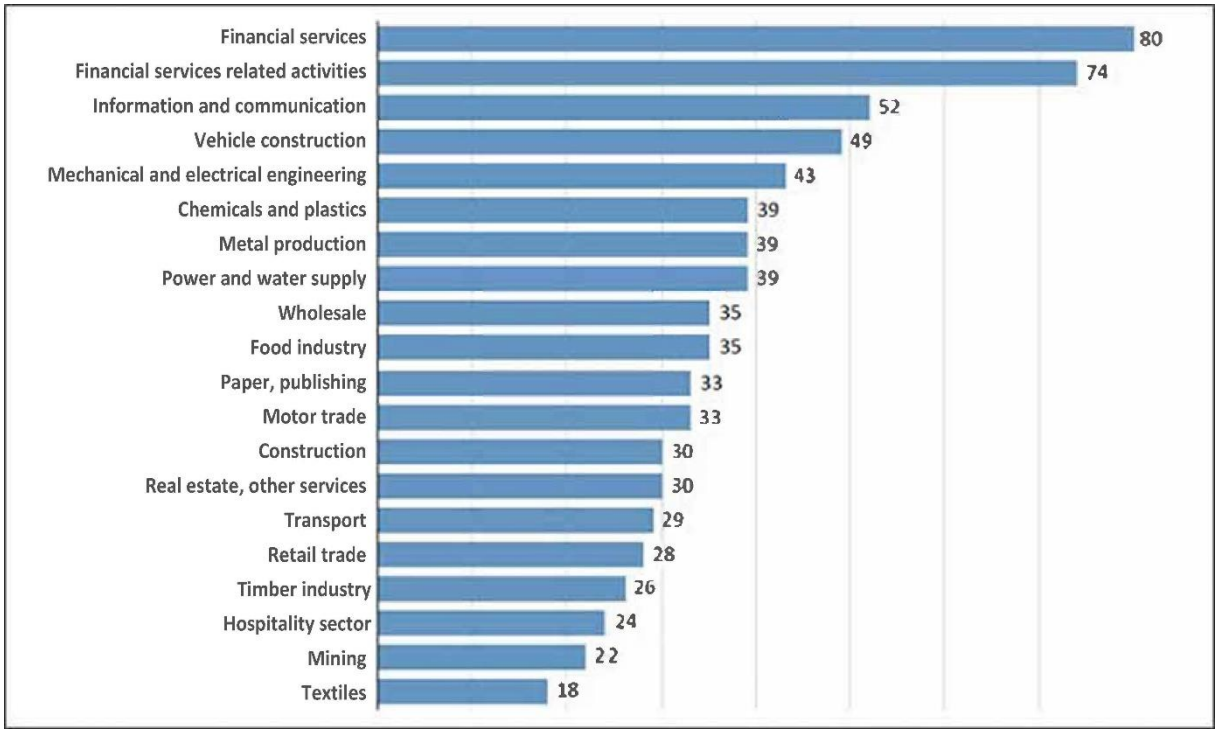
Figure 12: Share of companies active in continuing education by economic sector – in percent



Source: Statistics Austria (2023a), Continuing Vocational Training Survey (CVTS6), page 19

Looking at participation in continuing education courses, in 2020 35% of employees in the companies surveyed took part in courses as part of continuing in-company training. In line with the participation rate in continuing vocational training overall, the participation rates in continuing training courses also varied depending on the number of employees and the sector in which the companies operate. While 80% of employees in the financial services sector attended continuing education courses, only 30% of employees in the construction sector did so (Statistics Austria, 2023a, page 20).

Figure 13: Proportion of employees who attended courses in 2020, by economic sector – in percent



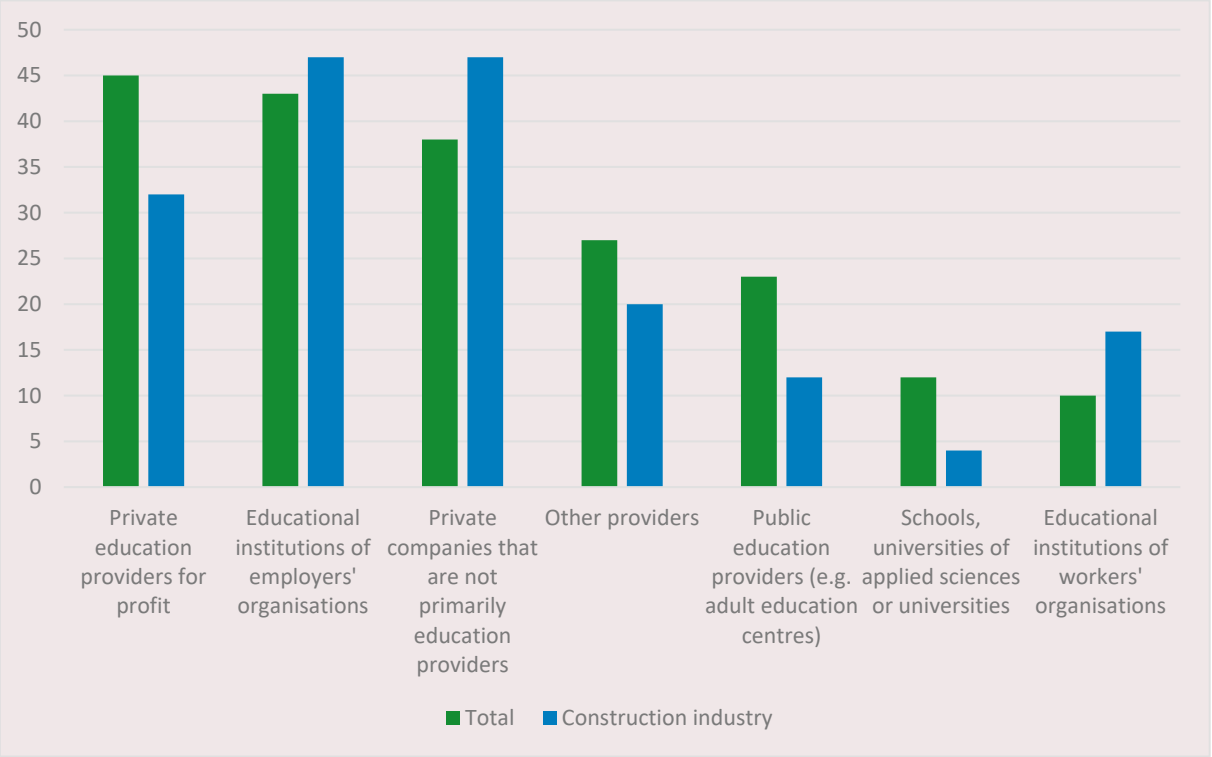
Source: Statistics Austria (2023), Continuing Vocational Training Survey (CVTS6), page 20

In terms of training intensity, on average each person participating in courses spent 19 hours of paid working time in continuing education courses. Viewed by sector, the construction industry is in the middle range in this respect, with 18 course hours in paid working time (Statistics Austria, 2023a, page 22).

The ratio of internal course hours in continuing education programs designed and conducted mainly by the company itself and external course hours from an outside provider is relatively balanced in the construction industry, with 56% internal and 44% external hours (Statistics Austria, 2023a, page 24).

Among the course providers of external courses, private companies that do not primarily implement training programs, such as manufacturing companies, suppliers, parent companies or partner companies in the group, were overrepresented in the construction industry compared to the average of all surveyed industries (47% of companies in the construction industry versus 38% of the surveyed companies). The same applies to training institutions of employers' associations (47% versus 43%) and of employee organizations (17% versus 10%). In contrast, compared to all surveyed industries, fewer companies in the construction sector used schools, universities of applied sciences or universities (4% versus 12%), public education providers (12% versus 23%) and private educational institutions for profit (31% versus 45%) as external course providers (Statistics Austria, 2023a, page 56).

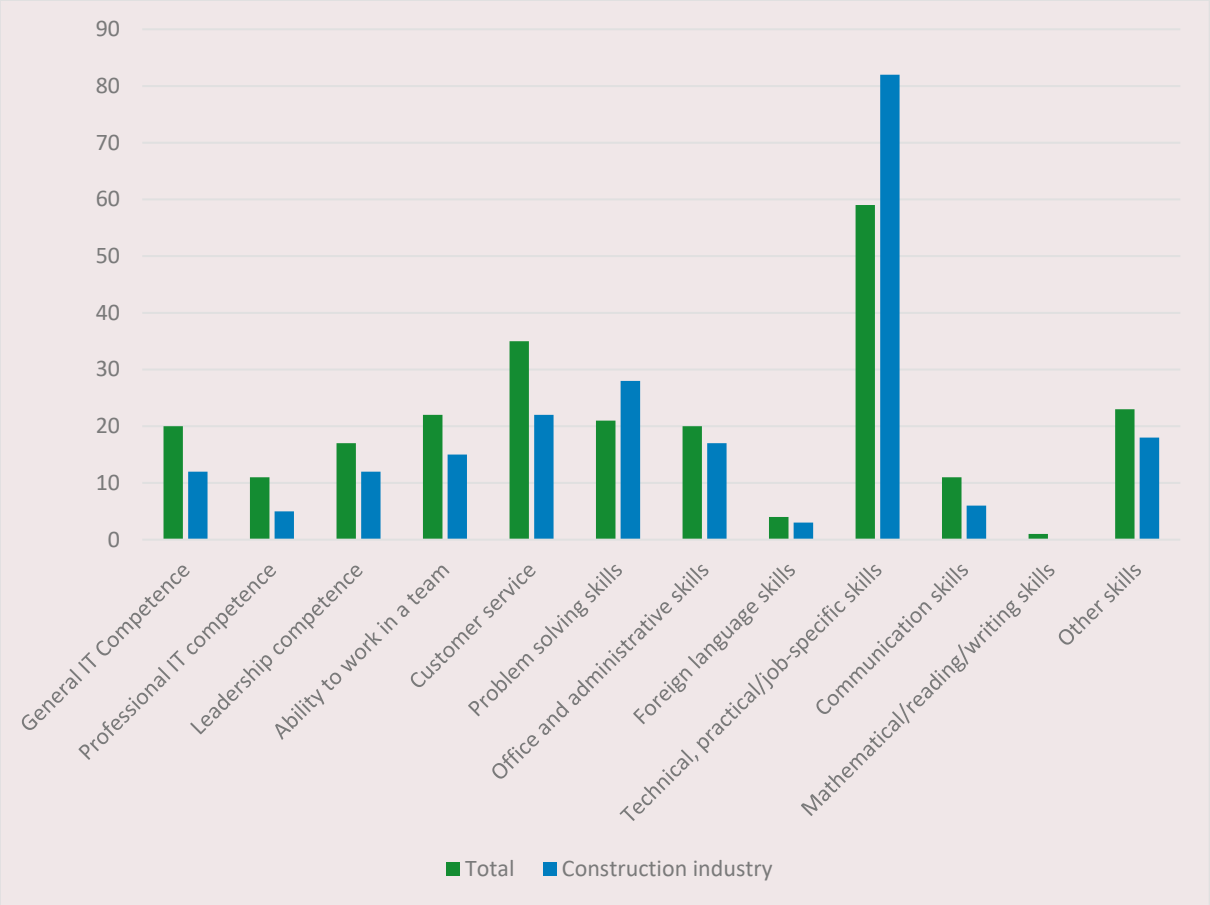
Figure 14: Companies with external courses according to course providers in the construction industry – in percent



Source: Statistics Austria (2023), Continuing Vocational Training Survey (CVTS6), own representation

In terms of course content, technical, practical or job-specific skills dominate across all sectors (59%), followed by courses on customer service (35%). In construction, as many as 82% of course-providing companies had their employees attend courses in which technical, practical or job-related skills were trained, followed by courses on problem-solving skills (28%) and customer service (22%). Comparatively rare were courses on general IT skills (12%) and on professional IT skills (5%), even rarer were foreign language courses (3%), and courses teaching basic knowledge in mathematical and/or reading/writing skills were virtually inexistent (Statistics Austria, 2023a, page 54).

Figure 15: Companies with continuing education courses by course content in construction – in percent

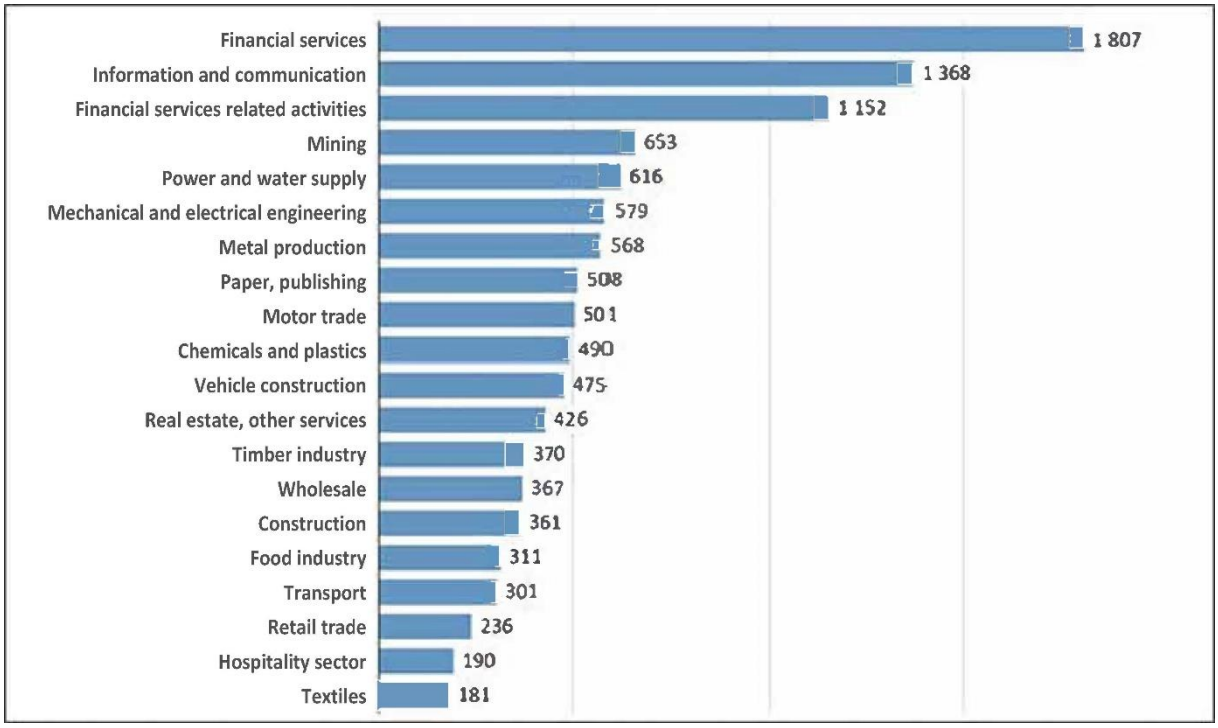


Source: Statistics Austria (2023), Continuing Vocational Training Survey (CVTS6), own representation

In addition to the participation rate, the costs spent on continuing education courses in the construction sector were also low compared to most other sectors. The total expenditure on continuing education courses (sum of direct course costs and wage-loss costs) amounted to 74.3 million euros in 2020 in the construction industry. Of this, 54.5% was accounted for by lost wage costs and 45.5% by corrected direct course costs (direct course costs plus contributions to public or inter-company institutions used to co-finance continuing education activities of other companies, minus subsidies or grants from public bodies (AMS, Länder) in the broadest sense). Almost three quarters of these direct course costs comprised course fees and honoraria (74%), while just under one fifth were accounted for by costs for the company's own training staff (18%) as well as travel costs and expenses (5%) and costs for infrastructure (3%). Overall, total training costs in construction were equivalent to 0.6% of personnel expenses for all companies in this sector. This was lower than the total costs of all companies in the manufacturing sector (0.8%), which has lower overall per capita spending on continuing education courses than the services sector (1.1%). While the total course costs in the financial services sector, as the top performer, amounted to an average of 1,807 euros for each person employed, in the construction sector only an average of 361 euros was spent on continuing education courses for each person employed. Looking at the costs per person attending, the costs in the construction sector were 1,208 euros, while in the information and communications sector they were more than twice as high at 2,633 euros. Similarly, the direct

course costs per course hour in the construction sector, at 25 euros, were below the average of 30 euros for all economic sectors, and were highest in the area of activities related to financial services, at an average of 45 euros (Statistics Austria, 2023a, page 58–63).

Figure 16: Total costs of continuing education courses per person employed by economic sector – in euros



Source: Statistics Austria (2023), Continuing Vocational Training Survey (CVTS6), Figure 16, page 30

An important aspect with regard to the question of whether companies invest in in-company training is their training policy. An essential basis for this is to identify the need for future skills and competences. Around three quarters of all enterprises (74%) reported conducting such needs analyses, with two thirds (66%) of these analyses being conducted irregularly and only around one third (34%) implemented as a fixed component of regular corporate planning (Statistics Austria, 2023a, page 32). In construction, only 60% of companies conducted needs analyses at all, and 80% of them did so irregularly, for example, only on the occasion of personnel changes. If a company's need for certain skills or competences was identified, then the following strategies were used in the construction industry to cover the skills deficit (Statistics Austria, 2023a, page 65–66):

- Around 77% of companies acquired new personnel who already had the required qualifications (80% of all companies overall);
- 65% of companies in the construction industry rely on training for their existing workforce (versus 79% overall);
- 59% reorganized operations to better leverage existing employee skills (versus 69% overall); and

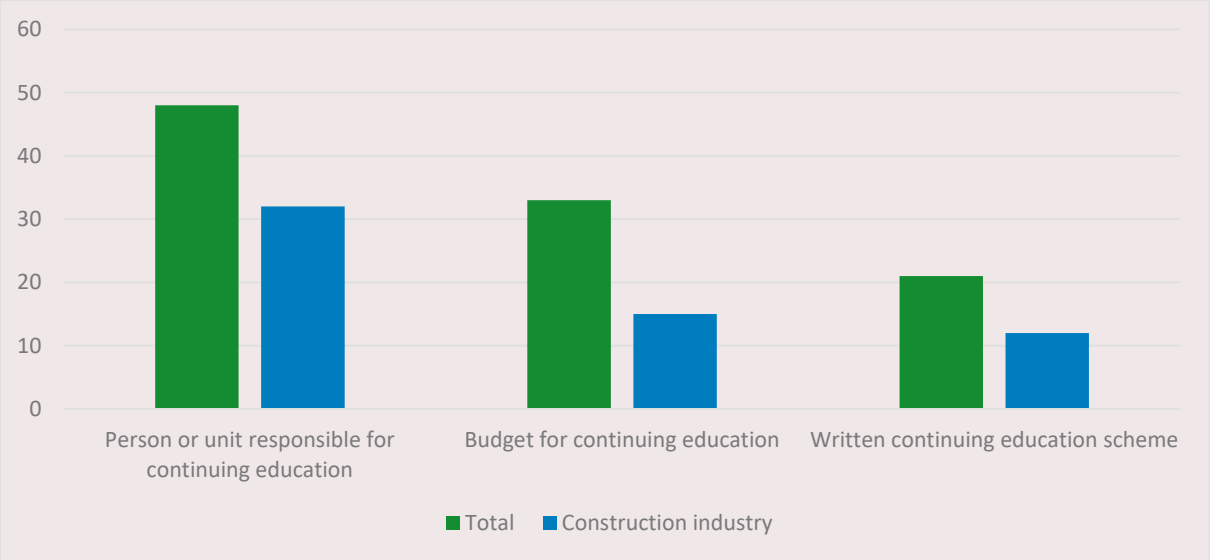
- 57% of companies in the construction sector hired new employees who were then trained accordingly (versus 66% overall).

With regard to participation in in-company continuing education, the importance of a professionalized continuing education policy on the part of companies has been repeatedly demonstrated. The elements of such a continuing education policy include, in addition to the systematic analysis of the competence needs of the company and the continuing education needs of the employees, also

- The existence of a person or unit responsible for continuing education, which just under half of the companies have,
- A dedicated budget for continuing education, and
- A written continuing education plan.

The construction industry shows below-average values for all the elements of a professionalized continuing education policy of the companies described above (Statistics Austria, 2023a, page 69).

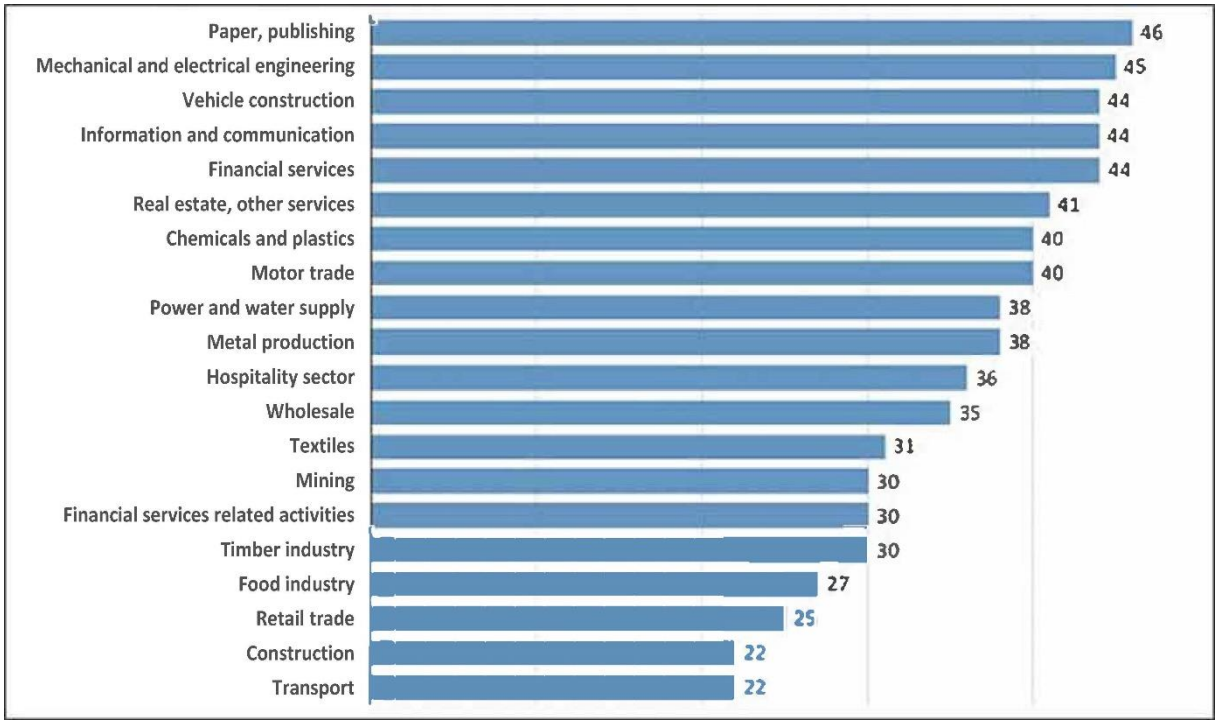
Figure 17: Elements of a professionalized continuing education policy in the construction industry – in percent



Source: Statistics Austria (2023), Continuing Vocational Training Survey (CVTS6) own representation

As part of the CVTS6, the participating companies were also asked about their training needs in the near future compared to the time of the survey. Here, too, there are clear differences depending on the size of the company or the sector. Above all, in paper and publishing (46%) and mechanical engineering (45%), a higher need for further training is expected in the next two years, while in transport and construction (22%), a lower need for further training in the near future compared to the current situation was forecast (Statistics Austria, 2023a, page 35).

Figure 18: Need for further training in the two following years – in percent

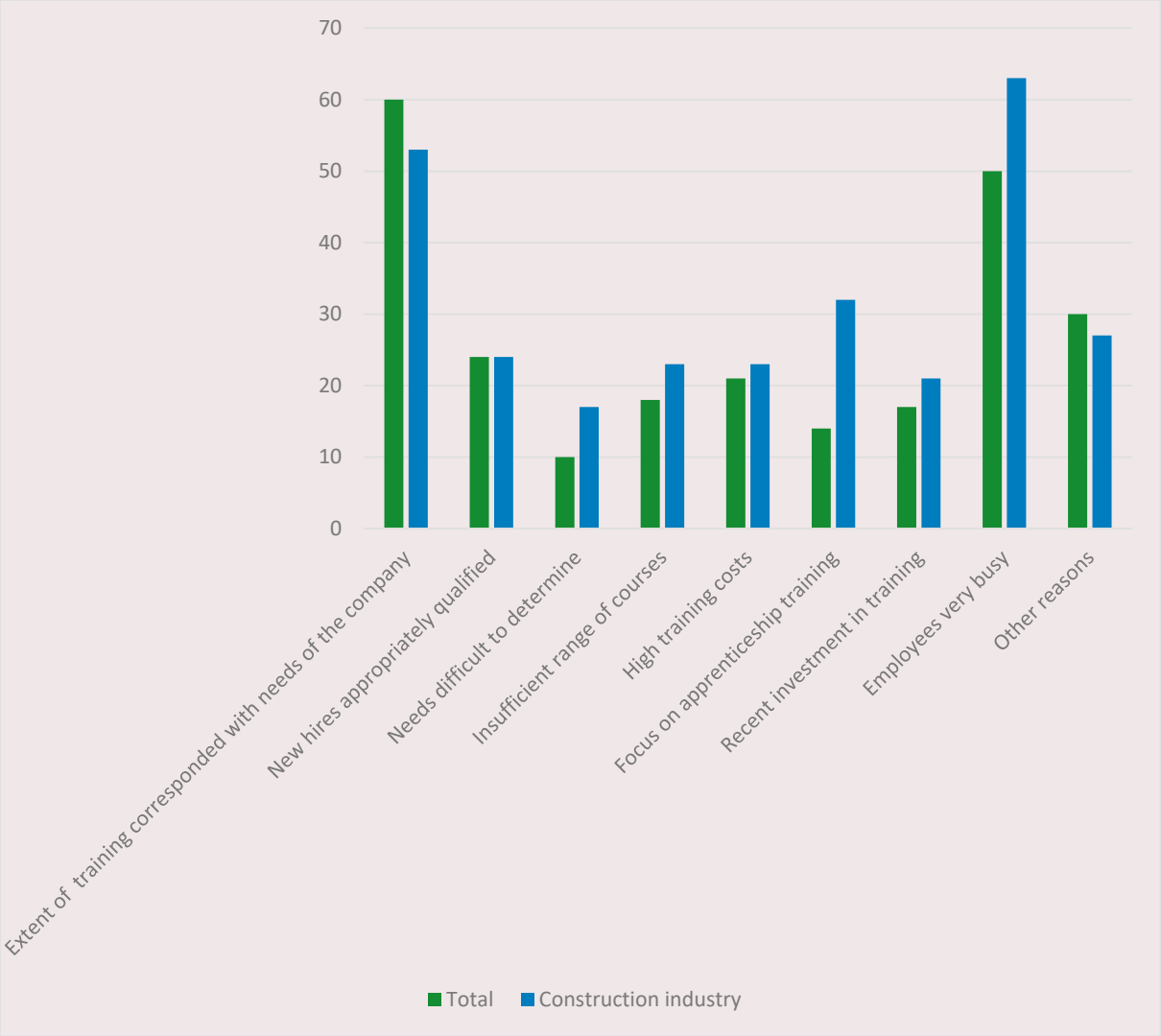


Source: Statistics Austria (2023), Continuing Vocational Training Survey (CVTS6), Figure 21, page 35

When asked which skills in general were considered important for the company's development over the next few years, of the companies in the construction sector, almost three quarters considered technical, practical ,or job-related specific skills (73%) important, more than two thirds teamwork skills (64%), and just under half problem-solving skills (48%). General IT skills (18%) were seen as less important, and only marginal importance was attributed to professional IT skills (3%), see Statistics Austria (2023a, page 67).

Asking companies active in continuing education about the reasons that prevented a higher level of in-company continuing education in 2020, 60% of these companies stated that the amount of existing continuing education met the company's needs. In the construction sector, this proportion was 53%. 63% of the companies in the construction sector that were active in continuing education cited a heavy workload of employees as an obstacle to a higher level of in-company continuing education, and 32% pointed to the central importance of apprenticeship training. Twenty-four percent cited new hires of suitably qualified people as the reason. Twenty-three percent cited insufficient course offerings or high course costs as obstacles. Twenty-one percent of the enterprises justified their level of further training activity with the fact that they had only recently invested in further training. For 17%, higher continuing education activity was prevented by the fact that the need was difficult to assess (Statistics Austria, 2023a, page 75).

Figure 19: Barriers to higher levels of in-company training in 2020 in the construction sector – in percent



Source: Statistics Austria (2023), Continuing Vocational Training Survey (CVTS6), own representation

Summary

The CVTS6 data on continuing vocational training in enterprises show that the construction industry as a whole has below-average or low values compared to other sectors in terms of continuing training activities of enterprises, participation rates of employees and continuing training expenditure, and this at a comparatively low level of qualification overall. This finding from the company survey is also consistent with the results of surveys of individuals such as the Adult Education Survey (AES), an EU-wide survey of adults (25- to 64-year-olds) on their educational activities. In this, respondents from the construction/building sector show notably low levels of continuing education activities compared to other sector members and the highest proportion of people who did not participate in any continuing education, at 21% (Statistics Austria, 2018). With regard to in-company continuing education, it should also be noted that it is generally highly dependent on company and individual decisions made by employees. According to Käpplinger's multi-level model of company decisions on continuing education (2016, page 132), these decisions are based on a range of various aspects. These

include, for instance, the question of whether to invest in continuing education at all or to what extent it should have elements of professionalized continuing education policy or competence (such as targeted surveys of training needs, persons responsible for continuing education, and a continuing education budget and plan). In addition, macro- and micro-didactic questions of the concrete design of continuing education measures in companies can be relevant.

5.3.5 Accreditation and certification/validation

In addition to education and training programs, the certification of knowledge and skills plays an important role to be able to use them in the labor market. Certifications are an essential means of providing assurance about the quality of products or services. In general, certification is understood to be a procedure by which compliance with certain requirements can be demonstrated by means of a certificate. This can involve the certification of persons or their competences, of systems or of products. Since the term "certificate" is not protected, certification in the non-statutory area can be carried out by any person or institution. In the legally regulated area, certification is understood to be the formal attestation of conformity by an impartial accredited body (certification body).

Accreditation is the formal recognition by an authoritative body (accreditation body) that a conformity assessment body fulfills the respective requirements applicable to it in terms of qualification and equipment and that it is thus considered competent to carry out tests, calibrations or certificates (conformity assessments). Accreditation is an important basis for ensuring the quality of services and goods and thus for successful participation in international competition. According to the Accreditation Act (Akkreditierungsgesetz, AkkG) 2012[71], the Austrian accreditation body is Akkreditierung Austria, an organizational unit of the Ministry of Economy, which accredits national conformity assessment bodies[72].

For the area of education and training, personal certifications are particularly relevant in order to prove existing professional competences. In Austria, certification of persons is carried out by certification bodies recognized by Accreditation Austria in accordance with the international standard DIN EN ISO/IEC 17024 ("General requirements for bodies certifying persons") and the Accreditation Act. These specify the requirements to be recognized and complied with by the certification body. They are often granted for a limited period of time. Currently, the following certification bodies for persons are listed in the register of accredited conformity assessment bodies of Accreditation Austria[73]:

- General Accident Insurance Institution, Safety Testing Laboratory (STP)
- Bureau Veritas Austria GmbH
- CIS – Certification & Information Security Services GmbH
- gbd ZERT GmbH

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[71] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20007798, retrieved on 18.01.2023

[72] https://www.bmaw.gv.at/Services/Akkreditierung.html, retrieved on 18.01.2023

[73] https://akkreditierung-austria.gv.at/overview, retrieved on 19.01.2023

- ImmoZert Certification Company Ltd.
- Austrian Society for Non-Destructive Testing (Österreichische Gesellschaft für zerstörungsfreie Prüfung, ÖGfZP)
- Austrian Gas and Water Association (Österreichische Vereinigung für das Gas- und Wasserfach, ÖGVW)
- Quality Austria – Training, Certification and Evaluation Ltd.
- SteelCert GmbH
- SystemCERT Zertifizierungsges.m.b.H.
- TÜV Austria CERT GmbH
- TÜV SÜD Country Company Austria GmbH
- Certification Body of the Economic Development Institute of the Austrian Federal Economic Chambers (WIFI)

These bodies carry out personal certifications for different areas or standards, for example for welding or brazing personnel, expert real estate assessment, quality or risk personnel, project or product managers, and for personnel in the fields of construction and building services engineering, refrigeration and air conditioning, photovoltaics or waste management/energy/environmental management. The respective requirements are described in the guidelines published by the testing bodies.

The certifications can be from the accredited or non-accredited area. Often, the certificates have a limited validity and must therefore be renewed via re-certification within a certain period of time. The completion of certain courses is not an absolute prerequisite for a personal certification, but they can be a good preparation for the certification.

Below are some examples of relevant personal certifications in the field of energy efficiency in the building sector in Austria from the accredited and non-accredited sector:

- Certified photovoltaic technician or planner (TÜV in cooperation with PV Austria)[74]

  The PV Austria Association, together with the TÜV Austria Academy, offers practical training for PV technicians with optional certification. The target group is electrical engineers, existing PV system installers, PV specialists such as electrical planners or PV roofers, and building technicians with basic electrical engineering knowledge. The course, which has been offered since 2016, consists of a basic block (3 days) and an in-depth practical block (2 days). According to the PV Austria homepage, as of 8.2.2023, 413 participants have been certified to date.

  The admission requirements for the optional certification exam are as follows:

  - Proof of completed training as a certified photovoltaic practitioner from the TÜV AUSTRIA Academy or an equivalent course,
  - Proof of a completed apprenticeship or higher education in electrical engineering, and

[74] https://pvaustria.at/pv-spezialist/ and https://www.tuv-akademie.at/kurs/ausbildung-zumr-zertifizierten-photovoltaikpraktikerin-tuevr-1, retrieved on 08.02.2023

- Proof of at least two years of professional experience, including at least one year in the field of construction, installation, and maintenance of photovoltaic systems.

The certification examination consists of a written examination in the form of selection tasks (single choice) and the elaboration of a case study as well as an oral examination. With a positive certification exam and fulfillment of all admission requirements, one receives the TÜV AUSTRIA certificate Photovoltaic practitioner, which is valid for three years, with the possibility of subsequent re-certification.

- Certified photovoltaic technician (WIFI)[75]

  At WIFI, the certificate Certified Photovoltaic Technician can be obtained according to the criteria of ÖNOEM EN ISO/IEC 17024. The target group is people from the service, administration, and production sectors who are responsible for planning photovoltaic systems or who accompany the planning process. Access requirements are

  - Completion of the training program "Photovoltaic technician" or a comparable training (at least 52 learning units) as well as
  - A completed school education or vocational training with six months of work experience, or
  - A minimum of six years of practical experience according to the scope of the competence profile.

  The certificate is valid for three years and can be extended within the scope of a re-certification.

- Certified heat pump installer or heat pump planner (AIT in cooperation with Austrian Heat Pump Association)[76]

  The AIT Austrian Institute of Technology offers a program for the certification of heat pump installers and planners in cooperation with the Austrian Heat Pump Association and the Federal Guild of Sanitary and Heating Installers. The certification was developed for installers and planners in order to increase the high quality in the heat pump sector. The personal certification takes place in a non-accredited framework. Prerequisites for certification are

  - Participation in all modules of the advanced training program "Planning and installation of heat pump heating systems" at the AIT or in an equivalent advanced training with at least 40 teaching units, whereby a practical part of at least five teaching units must be integrated,
  - The completed final course examination,
  - Proof of relevant training and, if applicable, relevant professional experience.

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75 https://zertifizierung.wifi.at/zertifizierungwifiat/personenzertifkate/dienstleistung/photovoltaikerin/zertifizierung_photovoltaikerin, retrieved on 08.02.2023

76 https://www.ait.ac.at/themen/training-education/weiterbildung-im-bereich-waermepumpen/personenzertifizierung-waermepumpen, retrieved on 08.02.2023

The certificate is valid for three years, after which re-certification is possible. A heat pump specialists register with the publication of the certified persons can be found at https://www.waermepumpen-fachleute.at/. As of 08.02.2023, 76 certified persons are listed there.

- Certified solar heat installer or planner (AIT)[77]

  The AIT offers the continuing education course "Certified solar heat installer or planner" and the compact course "Solar heat practitioner" in cooperation with klima**aktiv**, the climate protection initiative of the Ministry of Environment. Target groups are gas, water, and heating installers, planners, roofers, architects, technical offices, building services companies, and wholesalers. The courses teach theoretical and practical basics for the proper planning, installation, and assembly of high-quality solar heating systems.

- Bioheat installer certificate (Biomass Association)[78]

  The designation "Biowärme-Installateur" is a legally protected trademark of the Austrian Biomass Association for persons who have successfully completed the five-day basic seminar (4 days of theory, 1 day of practice) and can prove installation experience. The use of the trademarked designation is only permitted in the context of the activities of a heating installer. The training has been carried out since 2000 by the Austrian Biomass Association in cooperation with the installer guilds. The certificate is valid for three years. An extension takes place through the completion of further bioheat installer seminars. All certificate holders are listed on the website of the Austrian Biomass Association.

- Certification as Eco-energy technician (WIFI)[79]

  The WIFI offers a personal certification as an Eco-energy technician (OET) for personnel whose task it is to promote the use of energy from renewable sources. It can be obtained after completing three training modules (Eco-energy technician for biomass, for heat pump or for solar and photovoltaic) and passing an examination. The certificate is based on the EC Directive on the promotion of the use of energy from renewable sources and the requirements of ÖNORM EN ISO/IEC 17024. The prerequisite is training as a plumber, heating engineer, electrical engineer, gas and sanitary engineer or refrigeration engineer, or proof of corresponding informally acquired skills and several years of relevant practical work experience. The certificate is valid for three years and can be extended via re-certification.

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[77] https://www.ait.ac.at/themen/training-education/training-im-bereich-solarthermie/solarthermal-installer-and-planner-n, retrieved on 08.02.2023

[78] https://www.biowaermepartner.at/biowaerme-installateur/zertifikat-biowaerme-installateur/, retrieved on 08.02.2023

[79] https://www.wifi.at/kursbuch/technik-technische-gewerbe/umweltschutz-umwelttechnik/oeko-energietechnik/oeko-energietechniker and https://zertifizierung.wifi.at/zertifizierungwifiat/personenzertifkate/dienstleistung/oeko-energietechnikerin-waermepumpe/zertifizierung_oeko_energietechnikerin_waermepumpe, retrieved on 08.02.2023

- klima**aktiv** bauen certificate of the WIFI[80]

  klima**aktiv** bauen is a seminar series of the WIFI in cooperation with the Ministry for Environment, which compactly teaches the techniques of climate-friendly, energy-efficient and sustainable building, taking into account the issuance of the energy performance certificate. The target group is professionals in construction, such as master builders, planners and architects. The WIFI course consists of five modules, each of which takes place on two seminar days and can be taken individually. After completing a project work and passing the final examination the certificate and with it the addition "klima**aktiv**" in the job title can be attained.

- Certified energy performance certificate producer (Quality Austria)[81]

  With regard to the EPBD – Energy Performance of Buildings Directive Article 17 (Independent Qualified Personnel), Quality Austria offers a training course for persons who are allowed to issue an energy performance certificate based on their authority or who are involved in this work. For this, Quality Austria cooperates with ARGE-STIBA HOLDING Akademie, ÖPWZ (Austrian Productivity and Profitability Center), the Austrian Building Academies and klima**aktiv**. After completion of the training (4 modules, 7 days in total) and an examination, certification can be obtained. However, the certification is not directly equivalent to the authority to issue energy performance certificates. According to several decrees of the Ministry of Economy, ten trades (including engineering offices) as well as civil engineers are listed).[82]

- Passive house planner/consultant and Passive house craftsman (PHI)[83]

  The Passive House Institute (PHI) in Darmstadt is a globally active and recognized independent research institute that enables the certifications "Certified passive house planner" and "Certified passive house craftsman" for passive house professionals. The prerequisite for certification is the successful completion of an international examination at an accredited examination provider. The competences to be proven can be acquired in special courses. Course and examination providers in Austria include the Austrian Institute for Building and Ecology (IBO); Neubau best energy – Neue Bauphysik und Energiedesign; the Krems University of Continuing Education, Department of Building and Environment; Salzburg University of Applied Sciences, Graz University of Technology; Sonnenplatz Großschönau; Vorarlberg Energy Institute; and Passive House Austria in Innsbruck.

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[80] https://www.wifi.at/kursbuch/technik-technische-gewerbe/umweltschutz-umwelttechnik/klimaaktiv-bauen/klimaschutz-baumeister-ausbildung, retrieved on 08.02.2023

[81] https://www.qualityaustria.com/produkt/zertifizierter-energieausweis-ersteller/?gclid=EAIaIQobChMIx_jMhquG_QIVQoXVCh3vXgmMEAAYAiAAEgJ0zPD_BwE, retrieved on 08.02.2023

[82] https://www.wko.at/service/wirtschaftsrecht-gewerberecht/Die_Befugnis_zur_Erstellung_von_Energieausweisen.html, retrieved on 08.02.2023

[83] https://cms.passivehouse.com/de/training/zertifikate/ and https://passivhaus-austria.org/de/qualitat/zertifizierung/, retrieved on 08.0.2.2023

The certificates are valid for five years and can be extended via re-certification. Certified passive house experts in Austria can be found on the homepage of Passive House Austria, which is also a member of the iPHA (International Passive House Association).

- Specialist for airtightness testing of buildings

  The Austrian Society for Thermography and Airtightness offers training as preparation for the certification as building airtightness personnel. The certification to perform blower door measurements is based on ISO 20807 (status: January 2023; Österreichische Gesellschaft für Thermografie, ÖGfTh)

  The content of the training is the safe handling of the measuring device, performing measurements correctly according to ÖNORM ISO 9972, creating a meaningful test report, performing leak detection safely, evaluating leaks, understanding the background of building physics, advanced applications, and combination of measurement methods. The certification of personnel for non-destructive testing according to a continuous system is carried out according to the standard ISO 20807 (https://www.thermografie.co.at/zertifizierungen/iso-20807).

  At the end of each five-year period following the initial or re-certification examination, the certification can be renewed for a further validity period of five years without training and examination.

- Specialist processor of external thermal insulation composite systems (ETICS) (ARGE Qualitätsgruppe Wärmedämmsysteme and WIEN-Zert[84] or TÜV Austria)[85]

  The ARGE Qualitätsgruppe Wärmedämmsysteme (ARGE QG WDVS; quality group of thermal insulation systems), in close cooperation with the BAUAkademien and the certification body of the City of Vienna for building products (MA39) WIEN-Zert, has developed a certification program for construction professionals for quality assurance in the field of thermal insulation. The target group is master builders, painters, bricklayers, plasterers who have at least six months of relevant experience on the construction site. The one-week training offered by the BAUAkademien comprises 40 hours and concludes with an examination by external auditors. Afterwards, the participants receive the certificate "ETICS Specialist processor" from WIEN-Zert. The certificate is valid for three years and can be renewed in a one-day refreshing seminar. The designation "Certified ETICS Specialist processor" may only be used by construction experts who have been trained in a corresponding advanced training course based on the current processing guideline for ETICS (VAR), tested and certified by WIEN-Zert.

  TÜV Austria also offers a personal certification for specialist installers of external thermal insulation composite systems. The target group of this certification program according to ISO/IEC 17024 are also persons working in construction and the ancillary construction trades. Admission requirements are the completion of a two-day basic course for ETICS specialists and at least six months of practical experience in the field of ETICS processing.

[84] http://zfv.waermedaemmsysteme.at/c/ausbildung, retrieved on 09.02.2023
[85] https://www.tuv.at/perszert-fachverarbeiter-waermedaemm-verbundsysteme/, retrieved on 09.02.2023

The certification examination consists of a written test and practical exercises in the course of the training. The certificate is valid for three years and can be extended by means of re-certification.

- BIM (Building Information Modeling) certification

  In terms of supporting better energy efficiency through increased use of building data modeling, BIM certification systems are important quality assurance tools. In Austria, several certification offers exist in this field, for example, from buildingSMART, TÜV Austria or WIFI.

  The certification program of buildingSMART Austria (bSAT)[86] aims at standardizing openBIM training content, accrediting training organizations and certifying individuals. It is based on a criteria catalog of buildingSMART International (bSI), which supports training providers in the provision of internationally standardized and recognized training courses. buildingSMART does not conduct training courses itself, but defines learning outcomes and regulates the accreditation of training providers as well as the testing and qualification of individuals. Training is always provided through bSAT training partners, such as the Überbau Akademie and TU Wien bi.f.

  The program is structured in two stages: the first stage is the "Professional certification – Foundation". Here, BIM basics are taught and certified. The second level, the certification "Professional certification – Practitioner" is aimed at BIM users with a focus on BIM coordination and BIM project control and management (Practitioner coordination and/or Practitioner management). The Foundation certifications (online exam) are conducted by the training partners on behalf of buildingSMART Austria. For the Practitioner certification, a board examination consisting of a practical paper and an oral examination before a bSAT board must be successfully passed at buildingSMART Austria.

  TÜV Austria offers the BIM personal certification "BIM Coordinator TÜV" and "BIM Modeler TÜV"[87] . BIM Modeler is the first step on the way to becoming a BIM Project manager. The second level, BIM Specialist coordinator, is aimed at people who are responsible for BIM processes and model management of the respective trade or who define cross-trade and cross-project processes as part of the overall coordination. The certificates are valid for three years and can be extended by way of re-certification.

  At the WIFI certification body, the personal certificate "Digital BIM Practitioner" (DBIMP) can be obtained according to the criteria of EN ISO/IEC 17024[88]. Prerequisites for certification are the completion of the WIFI certification program "Digital BIM Practitioner" or a comparable training (28 days), as well as a completed school education or vocational training and at least one year of professional experience, or proof of informally acquired competences and at least three years of relevant professional experience. The

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[86] https://www.buildingsmart.co.at/bim-ausbildung/professional-certification-program/ and https://www.ueberbau.at/bimcert/, retrieved on 09.02.2023
[87] https://www.tuv.at/personenzertifizierung-zertifizierte-r-bim-koordinator-in/ and https://www.tuv.at/personenzertifizierung-zertifizierte-r-bim-projektmanager-in/, retrieved on 09.02.2023
[88] https://zertifizierung.wifi.at/zertifizierungwifiat/personenzertifkate/dienstleistung/digital-bim-practitioner/zertifizierung_digital-bim-practitioner, retrieved on 09.02.2023

certificate is valid for three years, with the possibility of renewal by means of re-certification.

- Sustainability facility professional (IFMA)

  Facility Management Austria (FMA), a non-profit association for the promotion of facility management in Austria, offers facility managers the opportunity to obtain a certificate as a Sustainability facility professional (SFP)[89] via the certification program of the International Facility Management Association (IFMA). The certificate is aimed at facility managers who want to acquire particularly in-depth knowledge with regard to sustainability aspects. The focus is on the development and adaptation of sustainability strategies in FM, their implementation in the FM organization and the sustainable operation of real estate. Prerequisite for the certification is the successful participation in an e-learning program of IFMA consisting of 3 modules or a total of 12 sections, each of which must be completed.

In addition to personal certifications, existing competences of professionals can also be made visible and proven within the framework of validation processes. The term "validation" of non-formally and informally acquired competences emphasizes above all the possibility of recording and recognizing existing competences that are not certified by the formal education system. Within the framework of validation procedures, competences can be identified and documented in the course of formative validations, with the aim of reflecting on individual learning achievements and needs, and of opening up future educational or career paths. In summative validation approaches, competences are assessed against predefined standards (curricular or work-related requirements) and, where appropriate, certified so that they can be utilized in the education system or the labor market. Such certification and recognition of existing competences can take place not only in the form of issuing a corresponding certificate, but also, for example, in the form of admission to a (university) course, a shortening of an educational course through credit for learning outcomes, or admission to a final examination. Here are two examples:

- In the project "Du kannst was" (You got skills), which is implemented by the social partners in five federal provinces, persons without a vocational qualification but with several years of work experience have the possibility of admission to an apprenticeship-leave exam on the basis of § 23 (5) BAG[90] (Berufsausbildungsgesetz; Vocational Training Act). They are supported in identifying existing competences in the course of the validation procedure and, if necessary, in completing supplementary targeted further training, and are gradually guided to an apprenticeship-leave exam, including for the occupations of bricklayer or installation and building technician or heating technician[91].

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[89] https://www.fma.or.at/bildung-karriere/zertifizierungen/ and https://www.fm.training/topclass/topclass.do?expand-OfferingDetails-viaTC=1-offeringId=7600126, retrieved on 27.02.2023

[90] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10006276 Vocational Training Act, retrieved on 27.02.2023

[91] https://ooe.arbeiterkammer.at/service/broschuerenundratgeber/bildung/Projekt__Du_kannst_was__.html, retrieved on 17.01.2023

- In the tertiary education sector, it is possible to have vocational and non-vocational qualifications recognized at universities and higher education institutions in accordance with the amendment to the Universities Act 2021 (§78 (3) UG) and the Higher Education Act (§ 56 (3) HG)[92], respectively.

The overarching goal of such validation initiatives is to recognize competences regardless of where and how they were acquired and to promote permeability in the education system and lifelong learning (BMB/BMWFW, 2017).

5.4 Competence analysis of the existing education and training system

In order to determine to what extent the existing education and training system considers relevant competences, specific offers were examined in more detail. These include apprenticeship training, intermediate (BMS) and higher level (BHS) vocational schools, post-secondary VET courses and add-on courses, industrial master colleges, building craftsperson and master craftsperson schools, tertiary education, scientific continuing education within the framework of universities, and continuing education within the framework of state institutions, institutions under public law, interest groups, and commercial organizations.

With regard to the methodological approach, the first step was to select concrete educational offerings from the respective educational sector that had a direct connection to the building sector. In a further step, relevant competences and associated keywords were defined. On the meta-level, (1) competences for increasing energy efficiency and the use of renewable energies in the building sector, (2) competences for increasing the renovation rate and decarbonization of the building stock, and (3) competences for resource efficiency and circularity in the building sector can be recorded here (for a detailed list, see Table 9).

Table 9: Representation of relevant competences for the conducted competence analysis

(1) Competences to increase energy efficiency and the use of renewable energy in the building sector, as well as to establish zero-emission buildings	(2) Competences to increase the renovation rate and decarbonization of the building stock	(3) Competences to increase resource efficiency and circularity in the building sector
Competences for the implementation of measures to increase energy efficiency and the use of renewable energy	Competences for the implementation of deep renovations, including through modular and industrialized solutions	Competences to consider and optimize greenhouse gas emissions over the entire life cycle of buildings (by assessing the global warming potential)

[92] Universities Act (UG) https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20002128; Higher Education Act (HG) https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20004626

(1) Competences to increase energy efficiency and the use of renewable energy in the building sector, as well as to establish zero-emission buildings	(2) Competences to increase the renovation rate and decarbonization of the building stock	(3) Competences to increase resource efficiency and circularity in the building sector
Competences for new and existing nearly zero-energy buildings (NZEBs) and for bridging the gap to zero-emission buildings (ZEBs)	Qualifications for installers who optimize or renew heating and cooling systems as part of renovation projects	Qualifications related to circular construction and resource efficiency
d) Qualifications for the integration of renewable energy and efficient heating and cooling technologies, especially for the installation of heat pumps	Competences for energy modernization of historical (listed) buildings	Competences for using the level(s) framework
Digital skills to improve the energy efficiency of buildings, in particular through increased use of BIM		
Skills to improve the "intelligence" of buildings for better energy performance (based on the smart readiness indicator), in particular with respect to sensors, building controls, and building management systems		

Source: Own representation based on the specifications in the template provided for the status quo analysis[93]

This selection and definition formed the basis for the subsequent research in selected training regulations, curricula, organizational websites, and course databases for the predefined competences and keywords and for drawing conclusions about the competences taught. Because training content is sometimes presented in different ways, this method has a certain limitation in terms of information content, and the creation of content-related references is based on assumptions made by the project team.

The following chapters provide a detailed breakdown of the methodology used and the competences identified in each case, arranged according to the education sectors mentioned at the beginning.

[93] BUILD UP Skills template roadmap_v1.1.doc, provided by CINEA (European Commission, European Climate, Infrastructure and Environment Executive Agency), Unit D1 - LIFE Energy + LIFE Climate on 16.11.2022.

5.4.1 Relevant competences in apprenticeship training

Based on the training regulations (2008–2019) of a selected sample of apprenticeship occupations, we investigated to what extent the current apprenticeship training system takes into account specific competences. These competences contribute to (1) increasing energy efficiency and the use of renewable energy in the building sector and establishing zero-emission buildings, (2) increasing the renovation rate and decarbonization of the building stock, and (3) increasing resource efficiency and circularity in the building sector (see Table 9). The training regulations of the following ten apprenticeships were analyzed in detail for this purpose:

- Building waterproofing technology
- Roofer
- Disposal and recycling specialist
- Prefabricated house construction
- Structural engineering specialist, focus on new construction and refurbishment
- Wood technology
- Installation and building services engineering (including basic module building services engineering, main module gas and sanitary engineering, special modules ventilation engineering, eco-energy engineering, control engineering, and building services planning)
- Sun protection technology
- Heat, cold, sound, and fire protection technology
- Carpentry

For the analysis, the described "activities according to the occupational profile" and "skills and knowledge according to the occupational profile" in the training regulations were used. Since the terms used in the training ordinances to describe the activities and competences are only partially consistent with the terms used for the analysis, the results of the analysis are based on the professional assessment of the project team.

The broadest spectrum of relevant competences is covered by the apprenticeship occupations building construction specialist and installation and building services engineering. Other apprenticeships, such as sun protection technology and waste disposal and recycling specialist, are characterized by specialization in a few but relevant areas of competence.

In particular, most apprenticeships teach the relevant skills for implementing measures to increase energy efficiency and the use of renewable energies in buildings (a). In addition to content relating to technical-constructional aspects, such as the production of suitable building envelopes, the use of insulating materials and sealing materials, et cetera, this also includes the teaching of knowledge about building physics and building ecology.

Primarily acquired in the basic module or the main and special modules of the apprenticeship installation and building technology are the following competences: establishing new and existing nearly zero-energy buildings (NZEBs) and bridging the gap to zero-emission buildings (ZEBs) (c) as well as qualifications for integrating renewable energies and efficient heating and cooling technologies, in particular introducing heat pumps (d). In

the special module Eco-energy technology, knowledge is also taught about alternative energy generation (solar, heat pump and biogenic systems), construction, design and installation of solar collectors, heat pumps, pellet, wood chip, and biomass systems. In addition, the occupational profiles roofing and carpentry include positions on the assembly of installation and superstructure parts for solar and PV systems.

The acquisition of skills (g) to improve the "intelligence" of buildings with a view to better energy performance (based on the smart readiness indicator), especially with regard to sensors, building control and building management systems, is also made possible by the installation and building technology apprenticeship. This can be achieved, for example, by teaching knowledge about control and regulation techniques of alternative energy systems, among other things.

Competences (b) for carrying out deep renovations, also by means of modular and industrialized solutions, are related to the apprenticeship occupation Building construction specialist with a focus on renovation in the context of competences for implementing renovation work in building construction. This includes basic knowledge of the maintenance and renovation of concrete and reinforced concrete building components, flues, exhaust flues, and ventilation systems. In the context of the training of roofers, competences are also taught for the execution of repair, maintenance and service work on existing roof and wall surfaces. Knowledge of historical construction methods and monument protection as well as the application of historical construction methods in restoration work, which are also acquired in the occupation of building construction specialist, form the basis for competences in the energy modernization of historical (listed) buildings (h).

It can be assumed that qualifications for plumbers to optimize or renew heating and cooling systems as part of renovation projects (d) are taken into account in the occupational profile Installation and building technology. This is achieved through the acquisition of competences in the maintenance and repair of water supply and disposal systems, heat generators and consumers, ventilation and air conditioning systems, and alternative energy systems (such as solar collectors, heat pumps, pellet, wood chip and biomass systems) and their servicing and troubleshooting.

Qualifications in connection with circular construction and resource efficiency (e) are seen in particular in connection with the occupational profile of the teaching profession of waste disposal and recycling specialist. In it, among other things, the basics of material flow management, material flow analysis are taught. Knowledge of residual materials arising in the work area relevant to the occupation as well as the properties, possible uses, and processing options of construction materials to be used as well as their testing, transport, and storage are included in the occupational profile of building waterproofing technology. Competences for the consideration and optimization of greenhouse gas emissions over the entire life cycle of buildings (by evaluating the greenhouse potential) (e) are related to the teaching of basic knowledge of building ecology, for example in the apprenticeship occupations of carpentry and prefabricated house construction. In the job description of the apprenticeship roofing, there are also positions on the production of green roofs and façades.

Teaching content relating to digital skills to support better energy efficiency in buildings, in particular through the increased use of Building Information Modeling (f) could not be clearly

identified in the analysis of the training regulations. On the other hand, the teaching of knowledge and the use of occupation-specific software as well as sector and company-specific electronic data processing and possibilities of computer use in the creative design of drafts are part of various training programs. Competences for the energetic modernization of historic (listed) buildings (h) are not explicitly considered in any apprenticeship. In the apprenticeship occupation building construction specialist, however, knowledge of the application of historical construction methods in restoration work is taught.

The results of the study correlate with the contents of the study "Competences for a Climate-Neutral Future" commissioned by the BMK (Tretter, et alii, 2022). In this study, future competences for the implementation of measures to increase energy efficiency and the use of renewable energies in buildings (assembly of installation and superstructure components for solar and PV systems) are identified, for example, in the area of the apprenticeship roofing. In addition, the module apprenticeship electrical engineering (main module: electrical and building services engineering; special module: renewable energy) offers job profile positions so that apprentices can plan and install PV systems. General recommendations with regard to desirable future competences focus on apprenticeships and continuing education in the field of heating exchange (planning, installation of green energy technologies and especially heat pumps, et cetera) and in the field of thermal building envelope refurbishment (Tretter, et alii, 2022).

Summary:

An integral part of job profiles of most apprenticeships is contents for building up competences for the implementation of measures to increase energy efficiency and to use renewable energies in buildings (a) as well as for the consideration and optimization of greenhouse gas emissions over the entire life cycle of buildings (by assessing the global warming potential) (e). Other competence areas, such as qualifications related to circular construction and resource efficiency (e) or competences for the energy modernization of historic (listed) buildings (h), are only anchored in isolated apprenticeship programs. Specific competences for using the level(s) framework were not identified in any of the apprenticeship training programs. Especially in the training regulations of the apprenticeship occupations building construction specialist and installation and building services engineering, a broad range of the analyzed competences is covered.

5.4.2 Relevant competences in intermediate and higher level vocational schools

Intermediate vocational schools (BMS)

The extent to which relevant competences are taught in Intermediate vocational schools (BMS) is investigated by analyzing the curricula for technical, industrial and arts and crafts colleges (2016) in the areas of construction technology, electrical engineering, building services engineering and mechanical engineering. In the area of "Competences to increase energy efficiency and use of renewable energy in the building sector" (a), knowledge of sustainable and energy-efficient construction methods, and building services systems based on renewable energy and the theory of the energy performance certificate are taught,

particularly in the area of building technology. Knowledge on the integration of renewable energy and efficient heating technologies (heat pump) (d) is taught equally in the fields of electrical engineering, building services engineering and mechanical engineering. Skills to improve the intelligence of buildings (g) are supported by knowledge of mechatronics, building automation, regulations and controls in building services engineering, among others. However, there is no explicit mention of the smart readiness indicator in the curricula. Competences to increase the rate of retrofit and decarbonization of the building stock are taught through knowledge of basic retrofit techniques in building technology. However, modular and industrialized solutions are not referred to in the curriculum, nor is the energy modernization of historic (listed) buildings. Competences for increasing resource efficiency or optimizing greenhouse gas emissions (e) are taught in the curricula through teaching content on the use of solar energy, ecological building materials and building systems. However, topics with explicit reference to the increased use of Building Information Modeling (f), optimization of heating and cooling systems in the context of renovation projects (d), circular construction and resource efficiency (e), and competences for the use of the level(s) framework could not be identified based on the curriculum analyses.

Colleges for higher vocational education (BHS)

The competence analysis in the higher-level vocational schools (BHS) was carried out by examining the curricula (2015) of the higher federal technical colleges (HTLs) for the fields of building technology, electrical engineering, building technology, interior design and wood technology, and mechanical engineering. It is found that competences for increasing energy efficiency and the use of renewable energy in the building sector (1), increasing the renovation rate and decarbonization of the building stock (2), and increasing resource efficiency and circularity in the building sector (3) are particularly taught by offering curricula in the field of building technology. The relevant competence areas are also broadly represented in the area of building technology. In the fields of electrical and mechanical engineering, the competence focus is on increasing energy efficiency (a) and using renewable energies (d), for example, in terms of assessing building services systems for energy efficiency or skills for improving the "intelligence" of buildings through smart building and setting up and commissioning building automation systems (g). The development of competences for the consideration and optimization of greenhouse gas emissions (e) is represented by a wide range of teaching content in the fields of renewable energy systems, energy balancing, solar systems and solar architecture, ecology, and many more. Teaching content related to circular construction (e), energy modernization of historic (listed) buildings (h), and optimization of heating and cooling systems in renovation projects (d) could not be identified.

Summary

Particularly through the curricula of intermediate vocational schools (BMS), further relevant competences are built up in the areas of construction and building services engineering. The curricula in the fields of electrical and mechanical engineering focus on increasing energy efficiency and the use of renewable energies in building services installations. In comparison, competences to increase the renovation rate and decarbonization of the building stock as well as to increase resource efficiency and circularity in the building sector are less considered

in the intermediate vocational schools. Competences for using the level(s) framework could not be identified in the curricula of BHS and BMS.

5.4.3 Relevant competences in post-secondary VET courses and add-on courses

For the analysis of the relevant competences represented by the curricula of the special forms of the higher technical and industrial training colleges (post-secondary VET courses and add-on courses) as well as the preparatory courses for professionals for the technical specializations of building technology, electrical engineering, renewable energy, building technology and wood technology were examined. Competences for increasing energy efficiency and the use of renewable energy in the building sector (1), increasing the renovation rate and decarbonization of the building stock (2), and increasing resource efficiency and recyclability in the building sector (3) are primarily taught by offering course content in the areas of construction technology, building technology, and renewable energy, environment, and sustainability. In addition to topics on energy-efficient construction methods (a), energy certificate preparation, et cetera, there is also explicit content on low-energy and passive house concepts (c) as well as technical building equipment with heat pumps and other technologies for heat and cold supply (d). Topics related to the use of BIM (f) and energy-efficient building automation (g) are also integral parts of the curricula. Techniques for building refurbishment and improving the thermal condition of buildings and building envelopes are thematically covered, as is the economic and ecological evaluation of refurbishment measures (b). Competences for the consideration and optimization of greenhouse gas emissions are imparted through a wide range of courses, including energy and ecological assessment of buildings, life cycle assessment (e), dimensioning of thermal solar systems, et cetera. Although courses on recycling processes and networks as well as disposal logistics are offered, topics on recyclable construction methods (e) could not be clearly identified, nor could qualifications for the renewal of heating and cooling systems in the context of renovation projects (d) and competences for the energetic modernization of historic (listed) buildings.

Summary:

The curricula of the special forms of higher technical and industrial colleges as well as the curriculum of the preparatory course for professionals in technical fields largely cover the relevant topics. However, competences for the optimization and renewal of heating and cooling systems in the context of renovation projects as well as competences for the energetic modernization of historical (listed) buildings are given little consideration. In particular, the courses for professionals in the fields of building technology and renewable energy, environment and sustainability have a wide range of competences, while the field of electrical engineering focuses on skills for improving the "intelligence" of buildings in terms of better energy performance. Competences for using the level(s) framework could not be identified in the curricula.

5.4.4 Relevant competences in industrial master, building craftsperson and master craftsperson schools

The competence analysis of the curricula of industrial master (Werkmeister), building craftsperson (Bauhandwerker) and master craftsperson (Meister) schools is carried out in the fields of construction engineering, wood construction technology, electrical engineering, and installation and building services engineering. In the areas of construction engineering and wood construction technology, competences for the implementation of measures to increase energy efficiency and the use of renewable energies in buildings are taught through teaching content relating to resource-saving installations of technical building equipment and energy certificate calculation. Topics relating to low-energy and passive houses (a) are also explicitly mentioned. The development of skills to improve the "intelligence" of buildings is seen through content on smart buildings in the field of construction (g). An additional thematic focus is identified in the area of skills for performing deep renovations. Energetic-ecological refurbishments, refurbishment techniques, as well as building refurbishment and revitalization are topics that are along these lines (b, d). Emphasis is also put on teaching content for the development of skills for the consideration and optimization of greenhouse gas emissions over the entire life cycle of buildings (by assessing the global warming potential), for example, through the topics of building ecology and building ecology assessments, energy balances in the manufacture, transport and use of building materials (e). Less consideration is given to skills to support better energy efficiency of buildings through increased use of Building Information Modeling (f), as well as topics related to circular construction methods (e) or competences for energy modernization of historic (listed) buildings (h).

Summary:

The curriculum of building trade schools for professionals in the field of construction includes a wide range of skills. Other curricula, such as wood construction technology, electrical engineering or building technology, or the industrial master school for construction (Werkmeisterschule für Bauwesen), tend to focus on specific topics, such as skills for improving the "intelligence" of buildings in terms of better overall energy efficiency, teaching skills for carrying out deep renovations, and skills for considering and optimizing greenhouse gas emissions. Skills related to circular construction and resource efficiency or optimization and replacement of heating and cooling systems in renovation projects are only considered to a small extent.

5.4.5 Relevant competences in tertiary education

Within the framework of the competence analysis in the tertiary education sector, a similar procedure was applied as in the field of apprenticeship training. In this respect, core studies that directly refer to buildings were defined in a first step. Against this background, 20 Bachelor's degree programs, 23 Master's degree programs and 10 doctoral or PhD programs were identified in Austria (see Table 10).

Table 10: Relevant core studies in the tertiary sector

University	Bachelor's programs	Master's programs	Doctoral and PhD programs
University of Innsbruck	Architecture	Architecture	Architecture
	Civil and environmental engineering	Civil engineering	Technical sciences
Johannes Keppler University Linz			Technical sciences
University of Klagenfurt			Technical sciences
Vienna University of Technology	Architecture	Architecture	Technical sciences
	Civil engineering	Buildings science and environment	
		Civil engineering	
Graz University of Technology	Architecture	Architecture	Technical sciences
	Civil engineering sciences and industrial engineering sciences	Civil engineering – Structural engineering	
University of Natural Resources and Applied Life Sciences Vienna			Build like Nature: Resilient building, materials and society
University of Art and Industrial Design Linz	Architecture	Architecture	
University of Applied Arts Vienna		Architecture	Technical sciences
Academy of Fine Arts Vienna	Architecture	Architecture	Technical sciences
University of Applied Sciences Campus Vienna	Architecture – Green building	Architecture – Green building	
	Civil engineering – Construction management	Civil engineering – Construction management	
Carinthia University of Applied Sciences	Architecture	Architecture	
	Civil engineering	Civil engineering	
	Sustainable real estate management	Sustainable real estate management	
University of Applied Sciences Wiener Neustadt		Property management	
Salzburg University of Applied Sciences GmbH	Smart building – Energy-efficient building technology and sustainable construction	Smart buildings in smart cities – Energy infrastructure and district development	
University of Applied Sciences Kufstein Tirol Bildungs GmbH	Facility management and real estate	Facility management and real estate management	
Joanneum University of Applied Sciences GmbH	Construction planning and construction industry	Architecture	

University	Bachelor's programs	Master's programs	Doctoral and PhD programs
		Construction management and civil engineering	
FH Upper Austria Studienbetriebs GmbH	Civil engineering in structural engineering	Civil engineering in structural engineering	
University of Applied Sciences Burgenland GmbH	Building and power engineering	Building services engineering and facility management	
MCI Management Center Innsbruck – International University of Applied Sciences GmbH	Smart building technologies		
FHW Fachhochschul-Studiengänge Betriebs- und Forschungs-einrichtungen der Wiener Wirtschaft GmbH (FHW GmbH)	Real estate	Real estate	
UMIT TIROL – Private University for Health Sciences and Technology			Technical sciences
Total	**20 Bachelor's degree programs**	**23 Master's degree programs**	**10 Doctoral programs**

Source: Own representation

In addition to the core studies, there were also a number of studies, albeit not directly related to buildings, with a high relevance to the defined objectives at the strategic level (see Chapter 5.1.3). Examples include topics such as spatial and urban planning, which create important framework conditions for the construction of energy-efficient buildings. In total, 7 such Bachelor's and 17 Master's degree programs were identified (see Table 11).

Table 11: Studies in the tertiary sector with strategic relevance for the objective

University	Bachelor's programs	Master's programs
University of Vienna		Urban studies
Graz University	Earth sciences	Sustainable urban and regional development
University of Klagenfurt		Geosciences
University of Innsbruck		Sustainable regional and destination development
University of Klagenfurt		Geography and regional research: Regional transformations

University	Bachelor's programs	Master's programs
		Applied business administration with a major in energy and environmental management
Vienna University of Technology	Spatial planning and zoning	Infrastructure management
		Spatial planning and zoning
Graz University of Technology		Civil engineering – Infrastructure
		Geospatial technologies
University of Leoben	Geo-energy engineering	Applied geosciences
	Applied geosciences	Geo-energy engineering
University of Natural Resources and Applied Life Sciences Vienna	Landscape planning and landscape architecture	Landscape planning and landscape architecture
		Cultural engineering and water management
University of Art and Industrial Design Linz	Space and design strategies	Space and design strategies
University of Applied Sciences Technikum Wien		Ecotoxicology & environmental management
Carinthia University of Applied Sciences	Geo-information and environment	Electrical energy & mobility systems
Total	**7 Bachelor's degree programs**	**17 Master's degree programs**

Source: Own representation

In a further step, it was investigated to what extent relevant competences are currently taken into account within specific individual studies. These studies contribute to (1) increasing energy efficiency and the use of renewable energies in the building sector as well as establishing zero-emission buildings, (2) increasing the renovation rate and decarbonization of the building stock, and (3) increasing resource efficiency and recyclability in the building sector (for the detailed presentation of the competences see Table 9).

In order to find out, the curricula of the individual study programs were examined and, in some cases, searched for predefined keywords relating to the competences required according to their occurrence. In this context, it must be pointed out that the information content of this methodology has a certain limitation, since curricula of individual universities and colleges differ in terms of their content scope and structure, and some competences may be acquired via special electives. In addition, actual course content is often ultimately defined by the teachers themselves, or researching and reviewing descriptions of individual courses would have been too resource-intensive.

Bachelor's degree programs

At NQF level 6, 20 Bachelor's degree programs were found that were directly related to buildings. Of these, eight were at public universities and twelve at public universities of applied sciences. In view of the individual study programs, it could be shown that, in contrast to the public universities, universities of applied sciences already include relevant topics and competences in the study designations. Thus, at the universities of applied sciences, the

following Bachelor's degree programs were found: "Architecture – Green building" (University of Applied Sciences Campus Vienna) and "Smart building – Energy-efficient building technology and sustainable construction" (University of Applied Sciences Salzburg). Other examples are "Building and energy technology" (University of Applied Sciences Burgenland) as well as "Smart building technologies" (MCI Management Center Innsbruck – International University of Applied Sciences). At all public universities, in contrast, Bachelor's degree programs were consistently named "Architecture" or "Civil engineering". This situation was also reflected in the competence analysis during the review of the individual curricula. Accordingly, more relevant terms or competences tended to be found in the Bachelor's curricula of the public universities of applied sciences than at the public universities. This could be related to the fact that universities of applied pick usciences, due to their stronger economic orientation, are more responsive to current trends or address them more strongly to the outside world.

Competences for implementing energy efficiency and renewable energy measures in buildings were found consistently in all 20 Bachelor's studies, which therefore proved to be well-covered (1a, 20/20). More than half of the studies imparted competences for considering and optimizing greenhouse gas emissions over the entire life cycle of buildings (3e, 14/20), as well as digital skills to support better energy efficiency in buildings, especially through increased use of BIM (1f, 13/20). In the midfield were skills for performing deep renovation, including through modular and industrialized solutions (2b, 10/20). In the lower middle range were skills for integrating renewable energy and efficient heating and cooling technologies, especially for implementing heat pumps (1d, 9/20). These are directly followed by skills related to circular construction and resource efficiency (3e, 8/20) and skills for improving the "intelligence" of buildings for better energy performance, especially related to sensors, building controls, and building management systems (1g, 7/20). To a lesser extent, skills were found for new and existing nearly zero-energy buildings (NZEBs) and for bridging the gap to zero-emission buildings (ZEBs) (1c, 5/20). Qualifications for installers optimizing or renewing heating and cooling systems as part of renovation projects (2d, 1/20), competences for energy upgrades of historic (listed) buildings (2h, 1/20), and competences for using the level(s) framework (3e, 1/20) each occurred only once.

The most competences were covered within the study programs "Architecture" of the University of Applied Sciences Carinthia, "Smart building – Energy-efficient building technology and sustainable construction" of the University of Applied Sciences Salzburg GmbH and "Civil engineering in building construction" of the FH OÖ Studienbetriebs GmbH (8/11). These are closely followed by the study programs "Architecture – Green building" of the University of Applied Sciences Campus Vienna (7/11), "Sustainable real estate management" of the University of Applied Sciences Carinthia and "Architecture" of the Graz University of Technology (6/11). In fields of study such as "Facility management" and "Real estate management", hardly any relevant competences appeared from the point of view of the ReBUSk partners.

Master's degree programs

At NQF level 7, there were 23 Master's degree programs with direct relevance to buildings, 10 of which belonged to public universities and 13 to public universities of applied sciences. It

also became apparent that the designation of individual study programs at the universities of applied sciences already indicated relevant competences. In this context, the Master's degree programs "Architecture – Green building" of the University of Applied Sciences Campus Vienna, "Sustainable real estate management" of the University of Applied Sciences Carinthia and "Smart buildings in smart cities – Energy infrastructure and neighborhood renewal" of the University of Applied Sciences Salzburg can be mentioned.

Most master studies pointed to competences for considering and optimizing greenhouse gas emissions over the entire life cycle of buildings (3e, 20/23). Competences for implementing energy efficiency and renewable energy measures in buildings (1a, 18/23) were the second most frequently addressed in individual curricula, and ranked first among Bachelor's studies. In the middle range were digital skills to support better energy efficiency in buildings, especially through increased use of BIM (1f, 12/23), and competences for implementing deep renovation, including through modular and industrialized solutions (2b, 11/23). The lower middle range included competences for new and existing nearly zero-energy buildings (NZEBs) and for bridging the gap to zero-emission buildings (ZEBs) (1c, 10/23), and qualifications related to circular construction and resource efficiency (3e, 9/23). Skills for improving the "intelligence" of buildings for better energy performance especially related to sensors, building controls, and building management systems (1g), were cited in seven of 23 Master's programs, as were skills for energy upgrades of historic (listed) buildings (2h). To a lesser extent, qualifications for the integration of renewable energy and efficient heating and cooling technologies, especially for the introduction of heat pumps (1d, 6/23), and competences for the use of the level(s) framework could be identified (3e, 3/23). Qualifications for installers who optimize or renew heating and cooling systems as part of renovation projects did not appear in any curriculum (2d).

The Master's program "Architecture" of the Joanneum University of Applied Sciences covered the most relevant competences (8/11). Five programs addressed seven out of ten competences. These are "Architecture" of the Vienna University of Technology, "Civil engineering – Structural engineering" of the Graz University of Technology, "Architecture – Green building" and "Civil engineering – Construction management" of the Campus Vienna University of Applied Sciences, as well as "Smart buildings in smart cities – Energy infrastructure and neighborhood renewal" of the Salzburg University of Applied Sciences. No relevant competences (or only to a small extent) were found in the Master's degree programs "Real estate management" of the University of Applied Sciences Betriebs- und Forschungseinrichtungen der Wiener Wirtschaft (FHW) (0/11) and "Real estate management" of the University of Applied Sciences Wiener Neustadt (2/11). This is consistent with the findings from the analysis of the Bachelor's degree programs.

Doctoral and PhD studies

Since the curricula of the doctoral and PhD programs do not provide any information on the content, given that students specialize here themselves, it was only possible to show the number of studies directly related to buildings, which amounts to 10. This sum consists mainly of doctoral and PhD studies in the fields of "Architecture" and "Technical sciences". One course offered by the University of Natural Resources and Applied Life Sciences in Vienna stood out due to its subject-related title "Build like nature: Resilient building, materials and

society". Based on this title and the short presentation on the homepage of the university, it can be assumed that at NQF level 8, specific competences can be acquired. These include competences for increasing energy efficiency and using renewable energies (1a), considering and optimizing greenhouse gas emissions over the entire life cycle of buildings, circular construction and resource efficiency, as well as using the level(s) framework (3e).

Summary

It can be stated that some relevant competences have already found their way into the higher education sector. Accordingly, a number of Bachelor's and Master's degree programs were found that specialize in energy and resource efficiency in building construction. Most consistently identified were competences for implementing energy efficiency and renewable energy measures in buildings (1a), competences for considering and optimizing greenhouse gas emissions across the building life cycle (3e), and digital skills to support improved energy efficiency in buildings, particularly through increased use of BIM (1f). By far the least common in Bachelor's and Master's degree curricula were skills for integrating renewable energy and efficient heating and cooling technologies (1d), skills for using the level(s) framework (3e), and skills for installers who optimize or renew heating and cooling systems as part of renovation projects (2d). Furthermore, the analysis provided information about the fact that fields of study especially dedicated to topics such as facility and real estate management and the real estate industry have hardly any relevant competences anchored in their curricula. A corresponding need for development can be assumed here.

5.4.6 Relevant competences in continuing education in science

The competence analysis in the field of formal scientific continuing education identified numerous courses that had a direct building reference and were thus relevant to the project. They include 22 master courses with 60–90 ECTS credits, 24 university courses/modules with 18–80 ECTS credits, 7 university courses/modules with 1–17.5 ECTS credits, and 12 university seminars without ECTS credits. The majority of these offerings were covered by the public universities. In this context, the wide range of scientific continuing education courses in the field of building and environment offered by the University for Continuing Education Krems is highlighted. In order to ascertain to what extent relevant competences are currently taken into account in the field of continuing academic education, the following were examined, as pointed out in Chapter 5.4.2. Curricula and descriptions of courses offered by the respective universities and colleges were searched for predefined keywords related to the individual competences (see Table 9). Here, too, the information content is limited to a certain extent, and some of the competence assignments are based on the project team's professional assessments.

Table 12: Academic continuing education offers

University	Master's courses (60–90 ECTS, Master's degree)	University courses (18–80 ECTS, academic expert, certificate)	University courses/ modules (1–17.5 ECTS, certificate)	Continuing education seminars (no ECTS, confirmation of participation, certificate)
University of Vienna,	Housing and real estate law	Cooperative urban and regional development	The social region	

University	Master's courses (60–90 ECTS, Master's degree)	University courses (18–80 ECTS, academic expert, certificate)	University courses/ modules (1–17.5 ECTS, certificate)	Continuing education seminars (no ECTS, confirmation of participation, certificate)
Postgraduate Center	Cooperative urban and regional development		The smart region	
			The entrepreneurial region	
			The sustainable region	
			The resilient region	
University of Innsbruck, Coordination Office for Scientific Continuing Education			IQ Wood plan	
Vienna University of Technology, Academy for Continuing Education	Real estate management & valuation	Real estate & property management		Preparatory course for the qualification examination for master builder
	Sustainable construction	Sustainable construction		Building envelope: Planning – execution – monitoring
				Gründerzeit houses–- Constructive evaluation (engineering findings)
				Engineered timber construction: Part 1 & 2
Graz University of Technology, Life Long Learning	Lean construction management	Sustainable construction		Building Information Modeling
	Sustainable construction			Smart neighborhood development in small and medium-sized cities
				Housing and psychology
				Decarbonization and sustainability management
				Moisture and leakage monitoring
University of Natural Resources and Applied Life Sciences Vienna		Green building solutions		
University of Art and Industrial Design Linz, BASEhabitat	Master of advanced studies – Architecture			
	Master of architecture			

University	Master's courses (60–90 ECTS, Master's degree)	University courses (18–80 ECTS, academic expert, certificate)	University courses/ modules (1–17.5 ECTS, certificate)	Continuing education seminars (no ECTS, confirmation of participation, certificate)
University for Continuing Education Krems	Building Information Modeling	Digital building	Hybrid construction with wood	Balancing climate-neutral buildings
	Facility and property management	Real estate valuation	Building Information Modeling	
	International real estate valuation	Academic expert in rehabilitation	Life cycle assessment and life cycle cost calculation for buildings	
	Real estate management	Energy innovation engineering and management	Circularity in building construction	
	Conceptual preservation of monuments	Ecological garden and green space management		
	Redevelopment and revitalization	Mold in construction		
	Redevelopment and revitalization	Building physics and building simulation		
	Building innovation	Energy self-sufficiency coach		
	Energy innovation engineering and management	Energy efficiency manager		
	MBA Construction industry	Building automation		
	Ecological garden and green space management	Building services engineering		
		Multi-story wood hybrid building		
University of Applied Sciences Campus Vienna	Technical building equipment	Technical buildings equipment		
Salzburg University of Applied Sciences GmbH			Circular economy	
Fachhochschule Kufstein Tirol Bildungs GmbH	General management MBA – Focus real estate management	Facility manager	Preparatory course for the CIS Immozert and Court-SV examination permanent	Introductory course design theory
University of Applied Sciences Burgenland GmbH, AIM – Austrian Institute of Management GmbH	Professional MBA – Specialization real estate management	Real estate management		

University	Master's courses (60–90 ECTS, Master's degree)	University courses (18–80 ECTS, academic expert, certificate)	University courses/ modules (1–17.5 ECTS, certificate)	Continuing education seminars (no ECTS, confirmation of participation, certificate)
FHW University of Applied Sciences Degree Programs Business and Research (FHW GmbH), Vienna Management Academy		Integral building and energy management (University of Cooperative Education)		
Private University Seeburg Castle		Academic real estate manager		
		Academic real estate agent		
		Academic expert for real estate valuation		
Total	**22 Master's courses (60–90 ECTS)**	**24 University courses (18–80 ECTS)**	**7 university courses/modules (1–17.5 ECTS)**	**12 University seminars (no ECTS)**

Source: Own representation

At NQF levels 6–8, the picture in the field of continuing scientific education was quite similar to that in the field of tertiary education. In this respect, competences for the implementation of measures to increase energy efficiency and the use of renewable energies in buildings (1a) and competences for the consideration and optimization of greenhouse gas emissions over the entire life cycle of buildings (3e) were identified most frequently. A somewhat higher priority was given to qualifications for the integration of renewable energies and efficient heating and cooling technologies, especially for the introduction of heat pumps (1d). These were covered, in particular, in the Master's program "Sustainable building" at the universities of technology of Vienna and Graz and various continuing education programs at the University of Continuing Education Krems. Likewise, competences for the implementation of deep renovation, including through modular and industrialized solutions (2b), came somewhat more to the fore compared to the tertiary sector, which were predominantly addressed in offerings at the Vienna University of Technology and the University of Continuing Education Krems. Digital skills to support better energy efficiency of buildings were the fifth most common (1f), followed by skills for new and existing nearly zero-energy buildings (NZEBs) and for bridging the gap to zero-emission buildings (ZEBs) (1c), skills to improve the "intelligence" of buildings, and skills related to circular construction and resource efficiency (3e). To a small extent, skills for energy upgrading of historic (listed) buildings (2h) and skills for using the level(s) framework (3e) could be inferred. Qualifications for installers who optimize or renew heating and cooling systems in the context of renovation projects (2d) could not be assigned to any offer.

The most relevant competences were covered by the Master's and university courses "Sustainable construction" at the technical universities of Vienna and Graz, which addressed 7 of 11 defined competences in their curricula. These offerings thus proved to be particularly significant. This also applied to the Master's course "Building innovation" at the University of

Continuing Education Krems, to which 7 of 11 relevant competences could also be assigned. The Master's programs "Facility and property management" (5/11), "Renovation and revitalization" (5/11) and "Energy innovation engineering and management" (4/11) as well as the university programs "Academic expert in renovation" (5/11) and "Multi-story wood hybrid construction" (5/11) at the University of Continuing Education Krems were also noteworthy. The University of Applied Sciences Campus Wien also made a significant contribution to the broader coverage of relevant competences through its Master's and university course in "Technical building services" (5/11). In the field of academic continuing education, it should be noted that many small and flexible formats exist (for example, university courses, modules, seminars, micro-credentials), which cover competences in a particularly targeted manner and whose significance cannot be underestimated. Examples are the university courses or modules "Building Information Modeling", "Ecological and economic life cycle assessment" and "Balancing of climate-neutral buildings" of the University of Continuing Education Krems as well as the university course "Decarbonization and sustainability management" of the Graz University of Technology. This also applies to larger formats such as the Master's courses "Building Information Modeling" and "Conceptual preservation of historic buildings" at the University of Continuing Education Krems, which cover only a single area of competence due to their specialization, but do so in a comprehensive manner. Once again, offers with a focus on facility and real estate management proved to be conspicuous, as they did not address any relevant competences in their offer descriptions or in the higher education sector. Research also revealed educational offerings that are important at the strategic level, such as the modules of the University of Vienna on the topics of "The social region", "The smart region", "The entrepreneurial region", "The sustainable region" and “The resilient region".

5.4.7 Relevant competences in continuing professional development

The competence analysis in the area of continuing vocational education and training is based on the examination of the course and continuing education offerings of 49 governmental, public-law institutions, interest groups, and commercial organizations. Research of the course providers was based on the surveys of the Status Quo Report (Bittersmann, et alii, 2013) of the predecessor project and was expanded to include a broad search of current relevant course providers via search engines and the snowball system. To determine to what extent the institutions' offerings address relevant competences, the lists and descriptions of offerings available on the respective organizational websites were reviewed or course databases were searched for predefined keywords and competences (see Table 9). The result can be found in Table 23 (see Appendix II), where, in addition to the providers of continuing vocational education and training and their relevant offerings, the assignments to the competence areas according to Table 9 are shown.

By far the most frequently elicited competences relate to the implementation of measures to increase energy efficiency and the use of renewable energy in buildings (a). The same applies to consideration and optimization of greenhouse gas emissions over the entire life cycle of buildings (e), and digital skills to support better energy efficiency in buildings, in particular through greater use of Building Information Modeling (f). Comparatively less important are skills to increase the rate of retrofits and decarbonization of the building stock (2) and skills related to circular construction and resource efficiency (e).

A broad thematic field of competence is covered by the basic courses and continuation courses for energy consultants, which are offered by institutions in several federal provinces under the organization of the Arbeitsgemeinschaft Energieberater:innen-Ausbildung (ARGE EBA, working group on energy consultant training). A similar thematic competence variety is offered by the courses of other educational providers such as the Wirtschaftsförderungs-institut Österreich (WIFI; Economic Development Institute), Sonnenplatz Großschönau or the Ziviltechniker:innen-Akademie (zt: akademie; academy of civil engineers).

Thematically strongly delimited courses relate primarily to the development of competence in the use of Building Information Modeling (BIM). These are offered by organizations specializing in software use and digitization.

In summary, it can be said that almost all relevant fields of competence are covered by continuing education programs in the context of communities of interest and values.

5.4.8 Summary of the competence analysis by thematic field

Looking at all competence analyses of the individual education and training sectors, it becomes clear that the existing education and training system contains a broad spectrum of competences related to the analyzed topics. Considering the developed target definition for the national qualification roadmap (see chapter 5.1.4), the analysis was divided into three subject areas. The results are presented in the following sub-chapters.

Energy efficiency, use of renewable energies and zero-emission new builds

The teaching of skills for increasing energy efficiency and the use of renewable energies in the building sector, as well as for the establishment of zero-emission buildings, is already well anchored in curricula and syllabuses across all education sectors or well covered by existing further education programmes (see Table 13). This applies in particular to competences for the implementation of measures to increase energy efficiency and the use of renewable energies in buildings.

Skills for newly constructed nearly zero-energy buildings (nZEBs) and for bridging the gap to zero-emission buildings (ZEBs), as well as for the integration of renewable energies and efficient heating and cooling technologies, are somewhat less well anchored in the curricula analysed in the tertiary sector. However, it should be noted that lecturers and programme managers often have a great deal of flexibility when designing courses and programmes and it is at their discretion to integrate relevant content into compulsory courses or via electives. In the area of continuing professional development, there are programmes that address this subject area, but there still appears to be significant potential for improvement.

Teaching content relating to digital skills to support better energy efficiency in buildings and Building Information Modelling (BIM) (f) has hardly been explicitly anchored in the area of apprenticeship training and in secondary and higher vocational schools, although the teaching of knowledge and the use of industry- and occupation-specific software is very much part of the training programmes. However, this subject area is already well to very well covered in schools, vocational training and scientific continuing education programmes, and there is a wide range of continuing education courses on offer.

Skills for improving the "intelligence" of buildings are well to very well represented across all educational sectors - particularly in the fields of installation, building and electrical engineering. Training content in connection with "smart buildings", building automation, regulation and control technology, etc. is anchored here. The extent to which content in connection with the "Smart Readiness Indicator" such as network serviceability, comfort and convenience is already integrated cannot be estimated on the basis of the analysis carried out.

Table 13: Mapping of relevant competences related to energy efficiency, use of renewable energy, and establishment of zero-emission buildings by education sector

Education sector[1]	NQF level	(1) Competences to increase energy efficiency and the use of renewable energy in the building sector, as well as to establish zero-emission buildings[1]				
		a) Energy efficiency and renewable energies	c) Nearly zero-energy and zero-emission buildings	d) Integration of efficient heating and cooling technologies	f) Digital skills for energy efficiency, BIM	g) "Intelligence" of buildings (SRI)
Apprenticeship training[2]	NQF4	**XXX**	**XXX**	**XXX**	**X**	**XX**
Intermediate vocational schools (BMS)[3]	NQF5	**XXX**	**XXX**	**XXX**	**X**	**XX**
Colleges for higher vocational education (BHS)[4]	NQF5	**XXX**	**XXX**	**XXX**	**X**	**XXX**
Post-secondary VET and add-on courses (part-time)[5]	NQF5	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**
Industrial master colleges, building craftsperson and master craftsperson schools[6]	NQF6 / without assignment	**XXX**	**XXX**	**XXX**	**XX**	**XXX**
Tertiary education – Bachelor's degree programs[7]	NQF6	**XXX**	**XX**	**XX**	**XXX**	**XX**
Tertiary education – Master's degree programs[8]	NQF7	**XXX**	**XX**	**XX**	**XX**	**XX**
Tertiary education – doctoral studies[9]	NQF8	-	-	-	-	-
Continuing scientific education[10]	NQF6 / NQF7 / NQF8	**XXX**	**XXX**	**XXX**	**XXX**	**XXX**
Professional development[11]	Without assignment	**XXX**	**X**	**XX**	**XXX**	**XX**

Source: Own representation; qualitative assessment by the project team based on the competence analysis (compare Chapter 5.4), using curricula, syllabi, and descriptions of the selected training and continuing education programs.

Legend:
XXX ..... Mostly well covered
XX ..... Only partially covered or only in some of the educational offerings studied
X ..... Hardly or not at all covered
- ..... Evaluation not possible or not meaningful

[1] The following curricula, syllabi, and descriptions were used for the competence analysis for the individual education sectors.
[2] Training regulations for the apprenticeships building waterproofing technology, roofer, waste disposal and recycling specialist, prefabricated house construction, building construction specialist (focus on new construction and renovation), wood technology, installation and building technology, sun protection technology, heat, cold, sound, and fire protection technology, carpentry
[3] Curricula for technical, trade, and arts and crafts colleges (2016) in the fields of construction technology, electrical engineering, building technology, and mechanical engineering
[4] Curricula of higher federal technical colleges (2015) in the fields of civil engineering, electrical engineering, building technology, interior design and wood technology, and mechanical engineering
[5] Curricula of the special forms of higher federal technical colleges (post-secondary VET and add-on courses) and preparatory courses for professionals for the technical specializations of civil engineering, electrical engineering, renewable energy, building services engineering, and wood technology
[6] Curricula of industrial master colleges and building craftsperson and master craftsperson schools in the fields of construction engineering, wood construction engineering, electrical engineering, and installation and building services engineering
[7] Curricula of study programs in the field of architecture, civil engineering, real estate management, facility management, real estate management, et cetera
[8] Curricula of study programs in the field of architecture, civil engineering, real estate management, facility management, construction management, building technology, et cetera
[9] No evaluation possible, as students usually specialize themselves
[10] Curricula and descriptions of scientific continuing education offers with direct building reference
[11] Descriptions on organization websites and in course databases of professional continuing education offers (Appendix II:) with reference to the relevant competence areas

Increasing the renovation rate and decarbonisation of existing buildings

Table 14 shows that the transfer of skills for carrying out comprehensive building refurbishments is only partially embedded in the curricula and syllabuses of most education sectors, including skills for the use of modular and industrialised solutions. This area of competence is relatively well covered in the analysed curricula of building craftsperson and industrial master schools as well as by the existing programmes in the area of academic continuing education. Particularly in the area of continuing vocational training, a clear potential for improvement can be recognised here.

The skills analysis with regard to the qualification of installers for the optimisation and renewal of heating and cooling systems as part of renovation projects was only evaluated for the area of apprenticeship training and vocational secondary schools (BMS) as well as for further vocational training, as this corresponds to the typical qualification level. There is still room for improvement here, particularly in the area of continuing vocational training.

Skills for the energy-efficient modernisation of historic (listed) buildings are contained in the analysed curricula, syllabuses and offer descriptions to a limited extent or not at all. In some areas - for example in apprenticeship training for building construction specialists specialising in refurbishment, in individual Master's degree programmes and in some academic continuing education courses - topics such as monument protection, historic building structures, materials and techniques, or traditional building methods are addressed, but are not specifically linked to increasing energy efficiency in historic buildings.

Table 14: Mapping of relevant competences related to increasing the renovation rate and decarbonization of the energy supply in the building stock by education sector

		(2) Competences to increase the renovation rate and decarbonization of the building stock[1]		
Education sector[1]	**NQF level**	b) Deep renovation including modular and industrialized solutions	d) Optimization and renewal of heating and cooling systems in renovations	h) Energetic modernization of historical (monument-protected) buildings
Apprenticeship training[2]	NQF4	**XX**	**XXX**	**XX**
Intermediate vocational schools (BMS)[3]	NQF5	**X**	**XX**	**X**
Colleges for higher vocational education (BHS)[4]	NQF5	**XX**	-	**X**
Post-secondary VET and add-on courses (part-time)[5]	NQF5	**XX**	-	**X**
Industrial master, master craftsperson and building craftsperson schools[6]	NQF6 / without assignment	**XXX**	-	**X**

Tertiary education – Bachelor's degree programs[7]	NQF	**XX**	-	**X**
Tertiary education – Master's degree programs[8]	NQF7	**XX**	-	**XX**
Tertiary education – doctoral studies[9]	NQF8	-	-	-
Continuing scientific education[10]	NQF6 / NQF7 / NQF8	**XXX**	-	**XX**
Professional development[11]	Without assignment	**X**	**XX**	**X**

Source: Own representation; qualitative assessment by the project team based on the competence analysis (compare Chapter 5.4), using curricula, syllabi, and descriptions of the selected training and continuing education programs

Legend:
xxx ..... Mostly well covered
xx ..... Only partially covered or only in some of the educational offerings examined
x ..... Hardly or not at all covered
- ..... Evaluation not possible or not meaningful

[1] The following curricula, syllabi, and descriptions were used for the competence analysis for the individual education sectors.
[2] Training regulations for the apprenticeships building waterproofing technology, roofer, waste disposal and recycling specialist, prefabricated house construction, building construction specialist (focus on new construction and renovation), wood technology, installation and building technology, sun protection technology, heat, cold, sound, and fire protection technology, carpentry
[3] Curricula for technical, trade, and arts and crafts colleges (2016) in the fields of construction technology, electrical engineering, building technology, and mechanical engineering
[4] Curricula of higher federal technical colleges (2015) in the fields of civil engineering, electrical engineering, building technology, interior design and wood technology, and mechanical engineering
[5] Curricula of the special forms of higher federal technical colleges (post-secondary VET and add-on courses) and preparatory courses for professionals for the technical specializations of civil engineering, electrical engineering, renewable energy, building services engineering, and wood technology
[6] Curricula of industrial master colleges and building craftsperson and master craftsperson schools in the fields of construction engineering, wood construction engineering, electrical engineering, and installation and building services engineering
[7] Curricula of study programs in the field of architecture, civil engineering, real estate management, facility management, real estate management, et cetera
[8] Curricula of study programs in the field of architecture, civil engineering, real estate management, facility management, construction management, building services, et cetera
[9] No evaluation possible, since students usually specialize themselves
[10] Curricula and descriptions of academic continuing education offers with direct building reference
[11] Descriptions on organization websites and in course databases of continuing vocational education and training offers (Appendix II:) with reference to the relevant competence areas

Resource efficiency and circularity

Subjects and teaching content such as energy and ecological assessment of buildings, life cycle assessment, building ecology, ecological building materials or building ecology assessment can be found in almost all of the curricula and syllabuses analysed across all education sectors. In the area of vocational training and academic education, there is a wide range of courses with corresponding content. It can therefore be assumed that basic skills for the consideration and optimization of greenhouse gas emissions through the assessment of global warming potential are also taught in all the areas considered (see Table 15). Whether and to what extent the entire building life cycle is taken into account when teaching the course content, or whether the considerations are limited to individual life cycle phases (construction, operation), cannot be adequately assessed on the basis of the documents analysed.

With regard to qualifications in connection with circular construction and resource efficiency, a different picture emerges. Teaching content related to these competences can only be found very occasionally in the curricula and syllabuses analysed, especially in connection with waste management topics such as disposal and recycling. Teaching content in connection with the transformation to a circular economy is most likely to be anchored in the tertiary education sector and in continuing education and training programmes.

The term "level(s)" is not explicitly mentioned in any of the syllabuses, curricula or course descriptions analysed. Some competences in connection with the use of the Level(s) framework, such as the consideration and optimisation of greenhouse gas emissions along the building life cycle and the improvement of resource efficiency and circularity, are already partially mapped in some areas (see above). Teaching content on topics such as the efficient use of water resources, health-related aspects such as indoor air quality, climate resilience and life cycle cost analysis can be found sporadically in the tertiary sector and in the area of continuing professional development. In the tertiary sector, teaching content relating to building certification, or the EU taxonomy is anchored in some curricula, particularly at NQF7, which probably also transfers some basic skills for the use of the Level(s) framework.

Table 15: Mapping of relevant competences related to increasing resource efficiency and circularity in the buildings sector by education sector

Education sector[1]	NQF level	(3) Competences to increase resource efficiency and circularity in the building sector[1]		
		e) Optimization of GHG emissions over the building life cycle	e) Recyclable construction and resource efficiency	e) Use of the level(s) framework
Apprenticeship training[2]	NQF4	**XX**	**X**	**X**
Intermediate vocational schools (BMS)[3]	NQF5	**XX**	**X**	**X**

Colleges for higher vocational education (BHS)[4]	NQF5	**X**	**X**	**X**
Post-secondary VET and add-on courses (in-service)[5]	NQF5	**XXX**	**XX**	**X**
Industrial master colleges, building craftsperson and master craftsperson schools[6]	NQF6 / without assignment	**XXX**	**XX**	**X**
Tertiary education – Bachelor's degree programs[7]	NQF6	**XXX**	**XX**	**X**
Tertiary education – Master's degree programs[8]	NQF7	**XXX**	**XX**	**X**
Tertiary education – doctoral studies[9]	NQF8	**-**	**-**	**-**
Continuing scientific education[10]	NQF6 / NQF7 / NQF8	**XXX**	**XX**	**X**
Professional development[11]	Without assignment	**XXX**	**X**	**X**

Source: Own representation; qualitative assessment by the project team based on the competence analysis (compare Chapter 5.4), using curricula, syllabi, and descriptions of the selected training and continuing education programs

Legend:
XXX ..... Mostly well covered
XX ..... Only partially covered or only in some of the educational offerings examined
X ..... Hardly or not at all covered
- ..... Evaluation not possible or not meaningful

[1] The following curricula, syllabi, and descriptions were used for the competence analysis for the individual education sectors.
[2] Training regulations for the apprenticeships building waterproofing technology, roofer, waste disposal and recycling specialist, prefabricated house construction, building construction specialist (focus on new construction and renovation), wood technology, installation and building technology, sun protection technology, heat, cold, sound, and fire protection technology, carpentry
[3] Curricula for technical, trade, and arts and crafts colleges (2016) in the fields of construction technology, electrical engineering, building technology, and mechanical engineering
[4] Curricula of higher federal technical colleges (2015) in the fields of civil engineering, electrical engineering, building technology, interior design and wood technology, and mechanical engineering
[5] Curricula of the special forms of higher federal technical colleges (post-secondary VET and add-on courses) and preparatory courses for professionals for the technical specializations of civil engineering, electrical engineering, renewable energy, building services engineering, and wood technology.
[6] Curricula of industrial master colleges and building craftsperson and master craftsperson schools in the fields of construction engineering, wood construction engineering, electrical engineering, and

installation and building services engineering
[7] Curricula of study programs in the field of architecture, civil engineering, real estate management, facility management, real estate management, et cetera
[8] Curricula of study programs in the field of architecture, civil engineering, real estate management, facility management, construction management, building technology, et cetera
[9] No evaluation possible, as students usually specialize themselves
[10] Curricula and descriptions of academic continuing education offers with direct building reference
[11] Descriptions on organization websites and in course databases of continuing vocational education and training offers (Appendix II:) with reference to the relevant competence areas

5.5 Measures, initiatives, and instruments for transformation

The following chapter contains the results of research on existing measures, initiatives and instruments relating to capacity building and the development of skilled labour for the transformation of the building sector towards sustainability and climate neutrality. Chapter 5.5.1 first outlines the European framework. Chapter 5.5.2 presents existing instruments for monitoring economic, labour market and skilled worker developments. Chapter 5.5.3 contains an overview of existing measures to make the building sector more attractive to women and young talent, as well as to retrain employees and skilled workers with a focus on green jobs, technology and skilled trades, and digitalisation.

5.5.1 European framework for green and digital transformation

European Skills Agenda

The European Union has formulated several strategies to achieve its goals in the area of sustainable and smart transformation. One of these strategies is the Sustainable and Smart Mobility Strategy (2020), which aims to drive the transformation towards green and digital mobility. The aim is to strengthen the internal cohesion of the EU, reduce regional disparities, and improve connectivity and access to the single market for all regions. In this context, the EU emphasizes the importance of a skilled workforce and the implementation of the European Skills Agenda. The EU is facing a growing shortage of workers capable of meeting the challenges of green and digital transformation. Therefore, it is necessary to promote and ensure the retraining and upskilling (upskilling and reskilling) of workers so that they have the necessary qualifications to succeed in the new world of work. The reflection paper "Towards a sustainable Europe by 2030" and the European Pillar of Social Rights action plan also emphasize the importance of upskilling workers appropriately to create an innovative workforce capable of shaping green and digital transformations. The EU has set a 2030 target to increase adult participation in continuing education, which is currently below 40%, to 60% in order to improve employability, promote innovation, ensure social fairness, and close the digital skills gap. These efforts build on the following initiatives:

- European Skills Agenda
- Digital Education Plan
- Council Recommendation on vocational education and training
- Council Resolution on the European Education Area

The strategies "Industrial Strategy for Europe" and "SME Strategy", which were adopted in 2020, also refer to the importance of skills for green and digital transformation as well as upskilling and reskilling. In the "Commission Recommendation on Effective Active Support to Employment" (EASE), retraining and upskilling that meet the needs of the labor market are considered essential. Based on this, the potential of micro-credentials is also identified.

One of the key priorities of the EU, which are also defined as the focus of the European Education Area, are green and digital education. The aim is to improve competences and skills for the digital transformation, contribute to the green transformation, and strengthen sustainability competences (focus topics of the European Education Area). Lifelong learning is essential to create a culture of sustainability and thus promote job creation, economic growth, and social justice (Towards a sustainable Europe by 2030). In the "Council Recommendation on vocational education and training (VET) for sustainable competitiveness, social fairness and resilience", VET is seen as a driver for innovation and growth, preparing for digital and green transformations and high-demand occupations. In addition, the Commission presented the "Recommendations on individual learning accounts and on micro-credentials" at the Social Summit in Porto in May 2021. This could help member states to reach the target of 60% adults participating in continuing education, as announced in the Skills Agenda and the European Area Communication (2020).

Intelligent specialization

Cohesion policy is the main investment policy of the EU. It aims to achieve economic, social, and territorial cohesion by reducing disparities between the levels of development of different regions. In this sense, the Smart Specialization strategy (S3) has also been promoted, which addresses all three priorities of Europe 2020 – smart, sustainable, and inclusive growth (Foray, et alii, 2012). The smart specialization approach encourages increased interaction and collaboration among different stakeholders in innovation ecosystems, including at the international level, through the development of cross-border projects and international networks, and the strengthening or creation of European value chains. Thematic priorities of S3 are education and skills for smart specialization. This approach to smart specialization requires looking beyond national borders, which means that countries and regions should identify their competitive advantages through comparisons by presenting their national and international context to ensure learning examples and effective collaboration consequently (Dubois, et alii, 2009; Gänzle, et alii, 2018; Stead, et alii, 2016). EU cross-border and interregional cooperation is seen as a precursor to large-scale macro-regional cooperation arrangements at the supranational level (Dubois, et alii, 2009; Gänzle, et alii, 2018; Stead, et alii, 2016). Said EU directives thus form the basis for numerous regional, national as well as transnational initiatives, such as Girls go circular, Wider Society Learning Initiative, Centers of Vocational Excellence, Sectorial Skills Alliances or European Universities.

5.5.2 Existing instruments for monitoring market developments

There are several instruments used in Austria to monitor market developments.

- **Public Employment Service Austria (AMS):** The AMS uses various instruments to monitor developments on the labor market. One important instrument is the AMS Qualifications

Barometer[94]. It shows trends in the development of industries and occupations and forecasts future developments. In addition, there is the so-called "AMS Standing Committee on New Skills"[95], which is intended to anticipate future trends on the labor market. In 2023, the focus will be on the area of "Green jobs, green transition". Labor market forecasts are also published on an ongoing basis[96].

- **Skilled worker radar of the Austrian Federal Economic Chambers (WKO):** This tool of workplace advocacy visualizes important key figures (number of jobs, unemployment, number of apprentices, et cetera). However, the key figures only refer generally to the labor market[97]. Furthermore, a company survey on the demand for professionals is regularly conducted (for results see Dornmayr & Riepl, 2022).
- **Forecasts and economic reports of the Austrian Institute of Economic Research (WIFO):** WIFO regularly publishes forecasts and economic reports on economic developments. Labor market-related developments in various sectors are also repeatedly addressed in these reports[98]. In addition, there is a thematic platform on "Green transformation and energy systems"[99].

5.5.3 Initiatives to increase the appeal of the building sector and to retrain workers

In the following, existing initiatives and measures are presented that contribute to increasing the attractiveness of the building sector (or technical professions in general) for women and young talents or to supporting the retraining of employees and professionals.

- **Just Transition Action Plan Education and Training:** Just Transition is a process launched by the Federal Ministry for Climate Protection (BMK) together with stakeholders from politics, business, science, and civil society. Together they discussed which economic, social, and labor market policy-related issues and tasks need to be solved in order to master the transformation to a resilient, climate-neutral, and environmentally sustainable society and economy.[100]
- **Environmental Foundation:** The Environmental Foundation is a target group-oriented implacement foundation initiated by the social partners Austrian Trade Union Federation (Österreichischer Gewerkschaftsbund, ÖGB) and Austrian Federal Economic Chambers (WKO). It is implemented together with the Public Employment Service Austria (AMS), the Federal Ministry of Labor and Economy (BMAW), the Federal Ministry for Climate

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[94] http://bis.ams.or.at/qualibarometer, retrieved on 23.03.2023
[95] https://www.ams-forschungsnetzwerk.at/deutsch/qualibarometer/comlist.asp?first=1&woher=1&sid=474620050, retrieved on 23.03.2023
[96] https://www.ams-forschungsnetzwerk.at/deutsch/statistik/list.asp?sid=474620050&StatistikArt=4&first=1, retrieved on 23.03.2023).
[97] https://www.wko.at/service/zahlen-daten-fakten/Fachkraeftebedarf.html, retrieved on 23.03.2023
[98] https://www.wifo.ac.at/themen/konjunktur_und_prognosen retrieved on 23.03.2023
[99] https://www.wifo.ac.at/jart/prj3/wifo/main.jart?rel=de&content-id=1654802868501&reserve-mode=active, retrieved on 23.03.2023
[100] https://www.bmk.gv.at/themen/klima_umwelt/nachhaltigkeit/green_jobs/just-transition.html, retrieved on 22.05.2023

Protection, Environment, Energy, Mobility, Innovation and Technology (BMK) and in close cooperation with high-demand companies in the field of climate occupations.[101]

- AMS program **FiT Women in Crafts and Technology:** The FiT program is open to all women who have registered with the AMS as unemployed or seeking work. It is independent of prior education and qualification level.[102] More than 200 different training programs in crafts and technology are supported.[103]
- **ecotechnology austria:** The online career portal for green jobs as a joint project of the Federal Ministry of Climate Action, the job portal karriere.at, and Green Jobs Austria is intended to act as an information hub for the environmental industry and support fields of action of the Master Plan Green Jobs.[104] The Environmental Qualification Portal www.kursfinder.at lists training and continuing education in the environmental sector.[105]
- **Relevant funding programs of the Austrian Research Promotion Agency (Österreichische Forschungsförderungsgesellschaft, FFG):**
  - **FEMtech internships:** FEMtech internships for female students are designed to attract young female scientists to careers in applied research in the scientific and technical RTI sector (research, technology and innovation).[106]
  - **INNOVATORINNEN** (formerly w-fFORTE): With INNOVATORINNEN, the Federal Ministry of Labor and Economy (BMAW) aims to provide targeted support and visibility for women in applied, business-related research and innovation (R&I).[107]
  - **Qualification offensive:** The qualification offensive of the Federal Ministry of Labor and Economy (BMAW) strengthens Austrian companies in their digitization and innovation agendas.[108]
  - **Talent funding priority**: The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) pursues three goals with this initiative: inspiring young people for research and development, networking researchers with industry, and guaranteeing equal opportunities for all.[109]
  - **FEMtech – Women in research and technology:** With FEMtech, the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK) supports women in research and technology and creates equal opportunities in industrial and non-university research.[110]

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[101] https://www.aufleb.at/umweltstiftung, retrieved on 22.05.2023
[102] https://www.ams.at/arbeitsuchende/karenz-und-wiedereinstieg/so-unterstuetzen-wir-ihren-wiedereinstieg/fit-frauen-in-handwerk-und-technik, retrieved on 22.05.2023
[103] https://www.ams.at/unternehmen/service-zur-personalsuche/frauen-in-handwerk-und-technik, retrieved on 22.05.2023
[104] https://www.bmk.gv.at/themen/klima_umwelt/nachhaltigkeit/green_jobs/karriereportal.html, retrieved on 22.05.2023
[105] https://www.ecotechnology.at/de/content/gruene-ausbildung-weiterbildung, retrieved on 22.05.2023
[106] https://www.ffg.at/femtech-praktika, retrieved on 22.05.2023
[107] https://www.ffg.at/innovatorinnen, retrieved on 22.05.2023
[108] https://www.ffg.at/qualifizierungsoffensive, retrieved on 22.05.2023
[109] https://www.ffg.at/programm/talente, retrieved on 22.05.2023
[110] https://www.femtech.at, retrieved on 22.05.2023

- **Girls' Day:** Girls' Day has been held in Austria in some of the provinces since 2001. This is intended to provide an impetus for a trend reversal in the career orientation of girls and to give them a new perspective on the world of work.[111]
- **Jobs PLUS Training initiative of the Vienna Employment Promotion Fund (waff):** Among other things, further training as an installation and building services technician and as a refrigeration system technician is offered.[112]
- **Climate Protection Training Center of AMS and bfi Lower Austria:** In Sigmundsherberg (district of Horn, Lower Austria), Europe's first Climate Protection Training Center is expected to be completed in the fall of 2023 – including training in the areas of renewable energy, environmentally related building technology, and modern, energy-efficient house technology.[113]
- For the federal province of Styria, there is a collection of education and training programs for the topic area of green innovation from a wide range of education providers, summarized via the **Green Tech Academy Austria** (GRETA).[114]
- Under the umbrella of Facility Management Austria, various initiatives are underway to make the industry more attractive and promote women and young talent, such as the **mentoring programme of the FMe initiative** ("Women in Facility Management")[115] and the **Young Professionals initiative**[116] as a platform for young people with a connection to property-related topics.

[111] https://www.bundeskanzleramt.gv.at/agenda/frauen-und-gleichstellung/gleichstellung-am-arbeitsmarkt/girls-day-und-girls-day-mini/was-ist-der-girls-day.html, retrieved on 22.05.2023
[112] https://www.waff.at/jobs-ausbildung/jobs-mit-ausbildung/, retrieved on 22.05.2023
[113] https://www.ams.at/regionen/niederoesterreich/news/2022/06/ams-und-bfi-noe-errichten-1--klimaschutz-ausbildungszentrum-in-e, retrieved on 22.05.2023
[114] https://greentechacademy.at/, retrieved on 22.05.2023
[115] https://www.fma.or.at/netzwerk/fme-frauen-managen-exzellent/, retrieved on 29.02.2024
[116] https://www.fma.or.at/netzwerk/young-professionals-initiative/, retrieved on 29.02.2024

6 Relevant building skills projects

The following chapter provides an overview of project-relevant European and nationally funded projects implemented to date to build, deepen, and broaden competences in the building sector (compare Table 16) [117]. The listed selection of projects can be divided into projects (with Austrian participation) based on the European initiative BUILD UP Skills, the climate protection initiative klima**aktiv**, as well as the funding program Research Competences for the Economy of the Austrian Research Promotion Agency (FFG). The FFG funding program Research Skills for Business supports companies (primarily SMEs) in systematically building up and upgrading the qualifications of their existing research and innovation staff. At the same time, it serves to anchor business-relevant research priorities at Austrian universities and universities of applied sciences.[118] Research conducted has shown that a large number of the qualification projects carried out deal with current sustainability topics in the building sector.

[117] It is not possible to specify the respective project budgets with reasonable effort due to different data availability and different funding and financing models.
[118] https://www.ffg.at/forschungskompetenzen-fuer-die-wirtschaft, retrieved on 22.05.2023

Table 16: Selected relevant European and nationally funded projects for qualification in the building sector

Project	Timeframe	Funding source	Level of implementation	Objectives	Result	Consortium
ASBWI – Austrian sustainable building workforce initiative	11/2011–05/2013	Intelligent Energy – Europe (IEE)	National	Initiation of a national strategy process to develop an education and training roadmap for Austria	National roadmap by 2020 to improve the qualification of craftspersons in the construction sector	• Austrian Energy Agency • Energy Agency Styria • 17&4 Organizational Consulting Ltd.
BUILD UP Skills CrossCraft	11/2013–06/2016	Intelligent Energy – Europe (IEE)	National	Development and implementation of an Austria-wide training program for the continuing education of professionals in the construction industry	The following pilot courses were developed, implemented, and evaluated during the project period: • Construction site training "Everything tight?" – three-hour training on site • Basic training: "We build energy efficiency" – two-day training course • Compact course: "We build energy efficiency" – four-day training course • Construction site quality coach – three-day training course Special modules: "Renovation of old building fabric" and "Building services in construction site practice" – one-day further training	• Austrian Energy Agency • Energy Agency Styria • 17&4 Organizational Consulting Ltd. • Passive House Interest Group Austria • BauAkademie Lehrbauhof Salzburg
NEWCOM – New competences for building professionals	09/2017–08/2020	European Commission – Horizon 2020	Europe	Development of training content and a basis for making acquired competences visible and comparable across Europe	New training contents with clear competence descriptions based on "Units of Learning Outcomes" (ULOs) for flat roof and building waterproofing, comfort ventilation, and quality assurance (planning/installation/operation) were developed and corresponding training implemented. A competence database for Europe-wide comparability of acquired skills was created.	• Austrian Energy Agency • Energy Agency Styria • 17&4 Organizational Consulting Ltd. • Non-profit Limited Liability Company for Quality Control and Innovation in Building (EMI) • ViaEuropa Competence Centre • Innovation for life (TNO) • Dutch Knowledge Centre for the building and building services sector (ISSO)

Project	Timeframe	Funding source	Level of implementation	Objectives	Result	Consortium
BUSLeague – Dedicated to stimulate demand for sustainable energy skills in the construction sector	09/2020–02/202	European Commission – Horizon 2020	Europe	Implementation of continuing education with a focus on micro-learning, digital implementation, and Europe-wide recognition	Best practice examples were shared across Europe, new short training courses were implemented and evaluated, and new opportunities to increase demand for competence related to energy efficiency and renewable energy in the construction sector were identified and evaluated.	• Dutch Knowledge Centre for the building and building services sector (ISSO) • Austrian Energy Agency • University of Twente • Institute for Innovation and Development of University of Ljubljana • Alliance Villes Emploi • PRACTEE Formations • EnEffect, Center For Energy Efficiency • Bulgarian Construction Chamber • Valencia Institute of Building • Bauhaus • Limerick Institute of Technology • Irish Green Building Council
klima**aktiv education**	Ongoing	Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK)	National	Development of a work program for the education and training of specialists in the field of climate-friendly technologies and services for the establishment of a CO_2-free economy	Work program for education and training of specialists in the field of climate-friendly technologies and services	Implementation by the Austrian Energy Agency
Climate Dialog – Platform for climate-friendly communication	Ongoing	Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK)	National	Identification of competences particularly relevant in the short term for the needed transformation of existing infrastructure in the following areas: • Renewable electricity • Renewable heat • Building and renovation Identification of suitable approaches that help specialists acquire and use these competences in the short term	Working paper on measures to be taken in the field of education	Implementation by the Austrian Energy Agency
DigiPEQ – Competence building for the	Ongoing	Austrian Research Promotion Agency	National	Development of a customized qualification measure for the sustainable development and	Developed and implemented qualification measure for the development and	• University of Applied Sciences Technikum Wien (coordination)

Project	Timeframe	Funding source	Level of implementation	Objectives	Result	Consortium
sustainable development and implementation of digital, liveable plus-energy districts		(FFG), Qualification Seminars		implementation of digital, livable PlusEnergy-Quarters (PEQ) with the following objectives: • Increasing research, development, and innovation competence in the participating companies • Networking and establishment of collaborations Integration of the results into the teaching of the university partners	implementation of PlusEnergy-Quarters (PEQ) with the main topics: • Renewable local and regional energy supply • Energy flexibility • Digital infrastructure • Highly efficient buildings • Load shifting • Grid efficiency and sector coupling • User involvement Innovative cooperation and business models	• 30 further project partners from research and industry, see: https://projekte.ffg.at/projekt/3840321
ClimB! – Buildings and neighborhoods in climate change	10/2020–03/2021	Austrian Research Promotion Agency (FFG), Qualification Seminars	National	Development and implementation of a qualification measure for the adaptation of existing buildings and quarters with regard to increasing outside temperatures and further consequences and risks of climate change, including curriculum, didactic detailed concept, prepared teaching contents, developed teaching and learning materials as well as evaluation results	Developed and implemented customized qualification measure to increase the innovative strength of participating companies with regard to improving the climate resilience of buildings and neighborhoods, with a focus on the adaptation of existing structures	• University for Continuing Education Krems (coordination) • 10 corporate partners; https://projekte.ffg.at/projekt/3933814
TGA-LZA-SOLAR – Economic and ecological life cycle analysis of environmentally relevant TGA systems for residential buildings with high solar coverage	02/2021–07/2022	Austrian Research Promotion Agency (FFG), Qualification Seminars	National	Development and implementation of a customized qualification measure to enable participants to create both an economic and ecological evaluation of planned building services concepts for buildings with high solar coverage in the life cycle The guideline of the seminar is the standardization of building services concepts for solar energy-supplied houses with the key parameters low tech, cost optimality as well as increase of attractiveness of the solar house concept.	Developed and implemented qualification measure to optimize the building services equipment of residential buildings with high solar coverage in terms of their cost optimality and the lowest possible environmental impact of the building services equipment in a life cycle perspective	• University for Continuing Education Krems (coordination) • 11 corporate partners; https://projekte.ffg.at/projekt/4011105
GrünstattGrau – Innovation laboratory for the green city	08/2017–07/2022	Austrian Research Promotion Agency	National	Development and submission of an Austrian coordination and competence center for building greening	Among the findings: • Implementing a greened urban neighborhood with best practice sharing	GrünStattGrau Research and Innovation GmbH

Project	Timeframe	Funding source	Level of implementation	Objectives	Result	Consortium
		(FFG), ENERGY OF THE FUTURE			between the redevelopment target area and synergy areas throughout Austria • Over 300 network partners such as companies, research institutes, administration, politics, networks, et cetera Turnkey laboratory system including functional innovation rooms, technology and furniture, team of experts, tools, methodological know-how, event management, topic identification and project support for collaborative, interdisciplinary learning and development	
RENOWAVE.AT – Innovation lab for sustainable, climate-neutral building and neighborhood renovation	Ongoing	Austrian Research Promotion Agency (FFG), ENERGY OF THE FUTURE	National	Development and establishment of a remediation innovation laboratory for future-oriented remediation technologies	The innovation lab RENOWAVE.AT will act as a central contact point for collaboration on innovation projects in the field of remediation and will provide systematic and early access to innovative, scalable remediation concepts and sustainable remediation technologies within real development environments (open innovation principle).	RENOWAVE.AT eG
Digital findet Stadt – Platform for digital innovations in the construction and real estate industry	Ongoing	Austrian Research Promotion Agency (FFG), ENERGY OF THE FUTURE	National	The innovation lab "Digital findet Stadt" aims to support innovations in two central innovation fields – openBIM and smart buildings – by means of a customized service portfolio and thus to increase the degree of digitization and subsequently the productivity of the Austrian construction and real estate industry significantly.	Increasing the competitiveness of SMEs in particular, which make up almost 90% of the players in the Austrian construction and real estate industry, by: • Provision of relevant digital infrastructure • Innovation support for openBIM pilot projects and R&D projects • Targeted further training measures and know-how transfer Consultation of planned funding projects	Digital findet Stadt Ltd.
Timber Construction 4.0 – Development of collaborative	01/2021–07/2021	Austrian Research Promotion Agency	National	Development and implementation of a qualification seminar in order to use the small-scale structure of timber construction	Developed and implemented qualification measure for the establishment of a collaborative inter-company working and	• FH Campus Wien – Association for the Promotion of the University of Applied Sciences, Development and Research

Project	Timeframe	Funding source	Level of implementation	Objectives	Result	Consortium
construction and planning systems in multi-story timber construction		(FFG), Qualification Seminars		companies and to ecologize large-scale residential construction The qualification seminar aims to use the opportunities of the digital, regional and small-scale production structure through cooperative working methods of the timber construction companies, generate synergy effects and increased efficiency through networking and systematization and create the step to the large-volume scale with a climatically compatible construction method.	production relationship of several SMEs, each specializing in their own systematized components for multi-story timber construction	Center in the South of Vienna (coordination) • 6 corporate partners; https://projekte.ffg.at/projekt/3987176
Straw bale construction – Construction straw bales in planning and execution	04/2028–10/2018	Austrian Research Promotion Agency (FFG), Qualification Seminars	National	Development and implementation of a qualification seminar for actors in the field of sustainable building and renovation on the use of the alternative building material building straw bales in planning and execution	Developed and implemented qualification measure for the use of construction straw bales both as a planning aid and as guidance for executing companies	• Salzburg University of Applied Sciences GmbH (coordination) • 8 corporate partners; https://projekte.ffg.at/projekt/2952041
Small Wind Academy - Competence development in the field of planning and construction of small wind energy plants (KWEA) in populated areas	12/2027–05/2019	Austrian Research Promotion Agency (FFG), Qualification Seminars	National	Development and implementation of a qualification seminar that contributes to establishing small wind power in Austria in the long term and with appropriate quality and to developing its potential	Developed and implemented qualification measure that contributes to closing the existing qualification gap in the field of small wind power and enables participating companies to build up the know-how required for safe, efficient, economical, trouble-free and smooth operation of a WTG in populated areas	• University of Applied Sciences Technikum Wien (coordination) • 6 corporate partners; https://projekte.ffg.at/projekt/3248534
Q-SanDoKaID – Qualification seminar on refurbishment with diffusion-open, capillary-active interior insulations	02/2018–07/2018	Austrian Research Promotion Agency (FFG), Qualification Seminars	National	Development and implementation of the qualification seminar "Refurbishment with diffusion-open, capillary-active interior insulation" that provides planners and contractors with practical training in state-of-the-art science and technology and familiarizes them with software tools for simulating such insulation systems	Developed and implemented qualification measure for renovation with diffusion-open, capillary-active interior insulation	• Salzburg University of Applied Sciences GmbH • 5 corporate partners; https://projekte.ffg.at/projekt/2895817
IDEA – Innovation camp circular Design_BAU	03/2022–08/2022	Austrian Research Promotion Agency (FFG),, Qualification	National	Development and implementation of a qualification measure to increase the circularity of construction companies	Developed and implemented qualification measure for construction companies: In the innovation camp, companies learn to design	• Vienna University of Technology (coordination)

Project	Timeframe	Funding source	Level of implementation	Objectives	Result	Consortium
		Offensive, Innovation Camps S			their construction products and business models in a cycle-optimized way.	• 9 corporate partners; https://projekte.ffg.at/projekt/4439976
Software Energy -- Software programming for energy and building technology company	03/2022–08/2022	Austrian Research Promotion Agency (FFG),, Qualification Offensive, Innovation Camps S	National	Development and implementation of a 5-day training measure for small and medium-sized enterprises from the energy sector, focusing on systems for the generation and distribution of energy flows in residential, commercial & industrial buildings as well as across buildings at settlement and neighborhood level	Developed and implemented qualification measure for SMEs in the energy sector with a focus on software control of modern energy systems: • Methods and practices related to the development infrastructure • Development processes • Requirements engineering • Testing the code quality	• University of Innsbruck (coordination) • 13 corporate partners, see: http//projekte.ffg.at/projekt/4479908
QualiBuild – Sustainable upgrading of RTI personnel from industry and the construction sector	07/2022–09/2023	Austrian Research Promotion Agency (FFG),, Qualification Offensive, Innovation Camps M	National	Sustainable higher qualification of RTI personnel from industry and the construction sector in the fields of technical building equipment, digitization/data science and life cycle assessment	Existing RTI personnel at the participating companies upskilled through systematic competence and knowledge building in the fields of technical building equipment, digitization/data science and life cycle assessment	• AIT Austrian Institute of Technology GmbH (coordination) • 8 further project partners from research and industry
HdZ2Market – Competence enhancement for companies to develop and implement innovative, sustainable building concepts	04/2017–12/2018	Austrian Research Promotion Agency (FFG),, Qualification Networks	National	Enhancement of competences and qualification of research and innovation staff of successful companies in the market in the field of sustainable construction as well as increase of the innovation power of the participating companies in the addressed topics: • Economic and energetic efficiency of future building solutions and concepts • Alignment of the technological basis for future buildings and their supply or integration into the supply system	• Thematic workshops to provide know-how, skills and tools in respective building technologies • Excursions to future-oriented buildings in new construction and renovation • Long-term cooperation established between science and companies beyond the project consortium through networking, public relations and knowledge transfer	• Technikum Wien GmbH (coordination) • 20 further project partners from research and industry; https://www.ffg.at/projektdetail?pid=1732505

Source: Own representation

7 Skills gaps and qualification deficits

7.1 Introduction and methodological approach

Framework analysis

Developing robust strategies for education and training in the building sector requires a basic understanding of the directives, regulations, communications and other documents at the level of the European Union and the European Commission that are relevant to this field. This applies not only to topics directly related to the achievement of energy and climate goals (such as energy efficiency, renewable energy or circular economy), but also to indirectly relevant topics such as financing or free movement of workers. Therefore, for the identification of competence gaps and skill deficits, an in-depth framework analysis of existing laws, directives, regulations and other relevant documents on national and European level was conducted first (Geissler, 2022).

Scenario development

In addition to this framework analysis, the analyses on the status quo (chapters 3 to 5), and, in particular, the competence analysis (see Chapter 5.4), various assumptions were made with regard to possible future developments. For this purpose, two future scenarios were developed for the Austrian building sector, which are related to the achievement of the energy and climate targets. The scenarios were developed based on desktop research, an internal team workshop, and two feedback rounds with experts of the building and energy sector from the project consortium (compare Geissler, 2023). For one of the scenarios, a "forecasting approach" was chosen (Scenario 1 "Target focus 2030"), which assumes a continuation of the current energy and climate policy framework and already initiated measures in the building sector. This approach is comparable to the approach for the WEM scenario ("with existing measures") for the Austrian overall greenhouse gas balance. The WEM scenario was prepared by the Federal Environment Agency to show the possible development of greenhouse gas emissions of Austria and was applied, among other things, in the context of fulfilling the EU reporting obligation (compare Anderl, Gössl, et alii, 2021, page 145f; Anderl, et alii, 2022, page 61 and the following). It should be noted that a qualitative approach was used in this project, while the WEM scenario is based on a quantitative approach.

The second scenario developed (Scenario 2 "Target Focus 2050") is based on a "backcasting approach". In contrast to other methods of foresight, where current observed developments are extrapolated to a picture of the future, in backcasting the future as a vision represents the starting point. Based on this vision, relevant elements are identified and developments are defined that are necessary to achieve the desired future (compare Grêt-Regamey & Brunner, 2011).

To define this starting point for Scenario 2, based on the framework analysis performed, the existing greenhouse gas reduction targets and measures in Austria relevant for the future scenarios were identified for the period beyond 2030 to 2050. The targets, both overall and for the building sector in particular, were broken down to the sub-targets (increasing the renovation rate, decarbonizing the building sector by supplying renewable energy, and establishing zero-emission buildings). The results are presented in Chapter 7.2.1; they form the starting point (the "Future as Vision") for Scenario 2.

The two scenarios developed on these bases (see chap. 7.2.3) were discussed in several team workshops with the project consortium and examined with regard to their applicability for the planned collection of stakeholder feedback. Due to the high complexity of the framework conditions and influencing factors, it was decided to continue using only one of the two scenarios (scenario 2) for further processing with stakeholders.

Scenario 1 assumes achievement of the energy and climate targets in the building sector by 2030 and fulfillment of the existing obligations in the area of refurbishment rates and decarbonization. However, the more ambitious goals of climate neutrality by 2040 and 2050 will not be achieved with this scenario (compare also Anderl, et alii, 2022, page 61 and the following). Since the implementation of measures in the field of education and training as well as their effectiveness on the labor market can be expected to take several years, the project consortium decided to use Scenario 2. This assumes the achievement of climate neutrality by 2040 or 2050 and takes into account further aspects of the Green Deal. These include, for instance, the establishment of a circular economy in the field of material use and the preservation of natural capital. Scenario 2 uses these aspects as the basis for the further steps of the gap analysis and as the basis for the development of the national education and training roadmap for the building sector. For the stakeholder feedback, key elements and developments for Scenario 2 were presented in a short, structured, and easy-to-read text.

Gap analysis

Building on results of the previous work steps, a gap analysis was carried out to determine current and future qualification requirements for achieving the energy and climate targets in the building sector. The basis for this was the skills analysis of the existing education and training system carried out by the project team (see Chapter 5.4).

Stakeholder feedback on scenarios and gap analysis

Stakeholder feedback was gathered during a face-to-face workshop on March 29, 2023 at the Vienna University of Technology with about 60 experts, practitioners, and stakeholders from the construction and real estate industries, education and training, and labor market research. The workshop consisted of two parts:

Part 1: "The future of the Austrian building sector"

In the workshop, six topic walls were each supervised by two moderators, with each topic focusing on a central development area of the future scenario considered for the building sector:

1. Meeting the demand for housing

2. Urbanization versus revitalization of rural areas
3. Land consumption
4. Energy space planning
5. Technical developments – power supply
6. Technical developments – circular economy

In two discussion rounds of 15 minutes each, the participants could choose two topics for discussion. Based on a guiding question, the participants discussed possible future developments for each topic and ranked them on a scale diagram according to probability (x-axis) and necessity for achieving the goal (y-axis). Three additional questions were also discussed for each topic:

- What does this mean for workforce needs?
- Where are the challenges?
- What else is important?

The results of the workshop are presented in Chapter 7.2.3.

Part 2: "Climate-fit professionals in the building sector"

This workshop was conducted with around 60 experts, practitioners, and stakeholders from the construction and real estate industries, as well as from education and training, in order to gather their assessment of the required knowledge, skills, and competences of various groups of actors in relevant fields of action.

In short presentations, the participants were given an overview of the status quo of education and training in Austria with a focus on achieving the European and national energy and climate targets in the building sector. The interactive part lasted 45 minutes and the participants could choose and discuss two topics in two discussion rounds of 15 minutes each. A third, final workshop round was conducted as a "Gallery Walk". The participants could walk from poster to poster and rate the results of the previous discussions with sticky dots (red = most urgent need, green = greatest potential or greatest effectiveness).

During the interactive part, six thematic walls were each supervised by two moderators. Four topics revolved around the knowledge, skills, and competences required by various actors to achieve goals in specific fields of action:

1. Zero-emission new construction: Who needs to learn what?
2. Increasing the renovation rate: Who needs to learn what?
3. Decarbonization in existing buildings: Who needs to learn what?
4. Resource efficiency & circularity: Who needs to learn what?

Two other topic walls addressed necessary changes and measures to ensure sufficient qualified professionals to achieve the goals:

5. What needs to change in the area of education and training?
6. What needs to change in the design, construction, and real estate industries?

The topics were discussed based on a guiding question; results were recorded on self-adhesive slips of paper and assigned to different fields of action and groups of actors, distinguishing between the following groups of actors:

- Authorities
- Industry (manufacturers of products, components, parts)
- Planning
- Construction
- Management and operation
- Funding
- End customers/clients

The following supplementary question was discussed in each case: What else is important?

The results of the workshop are presented in Chapter 7.2.4.

7.2 Future scenarios for the building sector in Austria

7.2.1 Binding targets, achievability, and measures by 2030 and by 2050

Binding greenhouse gas reduction targets: timeframe and legal anchoring

European climate law

According to the European Climate Law of June 30, 2021 (Regulation (EU) 2021/1119, European Climate Law, 2021), the European Union must achieve the climate target of a greenhouse gas (GHG) reduction of "at least 55% net" by 2030 compared to 1990. Other targets by 2030 include increasing the share of renewable energy sources to 40%, and increasing energy efficiency by 36% to 37%.

Climate neutrality is to be achieved by the year 2050. Climate neutrality means that the then still existing, unavoidable greenhouse gas emissions (for example from agriculture, waste, or certain production processes) are compensated by carbon storage in natural or technical sinks (Anderl, Bartel, et alii, 2021).

Climate neutrality by 2040 in Austria

Added to this is the Austrian government's goal of completely decarbonizing the economy by 2040. The government program 2020–2024 provides for a comprehensive revision of the Climate Protection Act with a legal anchoring of climate neutrality by 2040 (Anderl, et alii, 2022, page 56)

The basic principle for reducing greenhouse gases is that the less energy is consumed, the easier it is to cover the demand with renewable energy sources. In the building sector, this means reducing the heating and cooling requirements of buildings as much as possible through appropriate properties of the building envelope and covering the residual energy requirements with renewable energy sources. In this context, buildings can also be viewed as a network, that is, several nearby buildings can be jointly supplied by a central system.

Targets and measures for greenhouse gas reduction in the building sector

In the following chapters, targets and measures for the building sector are assigned to the subcategories of the targets defined in Chapter 5.1.3 for the national qualification roadmap to be developed.

Increasing the renovation rate: reducing the energy demand of existing buildings

Simulations with estimates of previous renovation rates and the share of the housing stock (primary residences and secondary residences) in thermally inadequate condition conclude that achieving the Austrian government's goal of completely decarbonizing the economy by 2040 requires a rapid increase in the renovation rate to at least 2.5% by 2025 (Amann, Mundt, et alii, 2021, page 7)

Aman, et alii (2021) conclude in their study on "Capacity adjustment of the construction industry for an increased renovation rate" that the rate of deep renovations[119] would have to be increased to 1.4% by 2030 in order to bring the currently insufficiently renovated housing stock into the required thermal-energy condition by 2040:

> *"Scenario 3: rapid sharp increase in the refurbishment rate: This scenario is based on the idea of using the push for refurbishment for an overall economic recovery by already doubling the rate of deep renovation by 2025 and increasing it to 1.4% by 2030. As early as the late 2020s, an overall refurbishment rate of 2.5 will be achieved, and 3% by 2040. With such a development, it is possible to thoroughly refurbish the thermally and energetically inadequate housing stock by 2040."* (Amann, Goers, et alii, 2021, page 35)

In relation to the current total of almost 4 million residential units with primary residence, this corresponds to an annual thermal and energy refurbishment of 56,000 dwellings. The need for renovation is particularly high according to Aman, et alii (2021) for private rental housing and municipal housing, and comparatively low for non-profit rental housing. Owner-occupied homes are of particular importance because of their large number. Secondary residences pose a particular challenge.

It is anticipated that once a zero-emission housing stock is achieved, a similar level of retrofit will continue to be required to maintain the state of the art and for economic sustainability reasons.

The renovation rate has been stagnating for years at an average of 1.5% of main residential dwellings (sum of predominantly individual measures and deep renovations, subsidized and non-subsidized), which is around 60,000 units per year for around 4 million main residential dwellings. Window and boiler replacements in particular show a positive development, the latter recording an increase from 0.4% to 0.5% of the housing stock in 2020. Overall, an increase in the number of individual measures carried out has been observed in recent years,

[119] This includes measures on the building envelope and the energy system according to the funding regulations of the federal states.

but at the same time, the rate of deep renovations has decreased to 0.5% in 2019 (Amann, Goers, et alii, 2021).

However, deep renovations are essential for achieving the target in order to utilize the savings potential and avoid lock-in effects. The renovation concept of the energy consulting service, for example, is a suitable instrument for planning and implementing measures for deep renovation (improvement of the building envelope and subsequent conversion of the energy system to renewable energy sources) in the right sequence.

Decarbonization – renewable energy supply

According to the 2019/20 consumption survey by Statistics Austria, around 600,000 households in Austria heat with heating oil and around 1,000,000 households with natural gas, with heating oil being used primarily in households of pensioners (Lechinger & Matzinger, 2020). According to BMK, however, around 840,000 gas heating systems, 500,000 oil heating systems, and 80,000 coke or coal heating systems are currently in operation in Austria.[120]

Decarbonization of the building sector can theoretically be achieved by switching from fossil to renewable energy supply without implementing energy efficiency measures on the building envelope. The priority technologies for this are district heating connection with appropriate connection density (district heating supply with large heat pumps) and individual heat pumps, as well as biomass systems and thermal solar systems in rural areas. The use of green gas, green fuel oil, and synthetic fuels would allow continued operation of the gas and fuel oil infrastructure. However, the overall goal of the Green Deal is to decarbonize the economy as a whole. Green gas, green fuel oil, and synthetic fuels are needed to decarbonize high-temperature processes in industry and should not be used for low-temperature processes in the building sector. The requirement to decarbonize the entire economy highlights the importance of the "reduce demand first, then meet remaining demand with renewables" approach. Demand reduction should also be seen from the perspective of the regulatory framework, because the principle of "energy efficiency first" is becoming increasingly important (compare Proposal for a DIRECTIVE on energy efficiency (recast), 2021).

The Renewable Energy Expansion Act (EAG, 2021) is intended to ensure that Austria will be able to cover its annual national electricity demand entirely with renewable energies from 2030 onwards. Photovoltaics (PV) play a key role in this. To this end, electricity generation from photovoltaics is to be increased from around 1.5 terawatt hours (TWh) per year in 2019 to 11 TWh by 2030. The planned expansion to 11 TWh by 2030 represents roughly a tenfold increase in current installation numbers. As renewable electricity is increasingly needed to reduce greenhouse gas emissions in transportation as well as space heating, a further increase in electricity generation with PV systems to about 30 TWh by 2050 is considered necessary (Fechner, 2020).

In 2021, 740 MWp of capacity was newly installed in Austria. The installed capacity thus totaled 2,783 MWp at the end of 2021. This means that 2,782 GWh of energy was produced in

[120] https://www.bmk.gv.at/themen/klima_umwelt/energiewende/raus-aus-oel-gas.html, retrieved on 14.02.2023

2021 (Photovoltaic Austria, 2022). Given the above targets, annual installations by 2030 would have to be at least double the 2021 figure.

Zero-emission new construction

With regard to zero-emission buildings, there are currently no mandatory requirements in Austria. However, the reference NEKP developed by scientists (Grohs, et al., 2019) states that by 2050, building emissions must be reduced by 80–90% through appropriate measures in order to achieve the Paris climate target of 1.5°C.

New buildings must therefore be designed, built, and operated with a neutral GHG balance in mind. The technologies, materials, and tools for this are available, but the feasibility is primarily limited by economic framework conditions.

7.2.2 Framework conditions for the development of the scenarios

Based on the framework analysis of existing laws, directives, regulations, and other relevant documents at national and European level, the following relevant framework conditions were identified for the development of the scenarios:

- Digitization
- Circular economy
- Photovoltaics as a strategic pillar of the EU

Information on other selected framework conditions – namely population development, land use, the building stock, and the development of the labor situation in the construction sector – is presented quantitatively as far as possible in the following chapters.

Population development

Forecast of Statistics Austria estimates 9.22 million inhabitants in 2030, 3.2% more than in 2021 (based on January 1 of the year in question), and 9.63 million (+7.8%) in 2050 (ÖROK, 2022). Based on the current number of around 4 million primary residences, this corresponds – at a rough estimate and assuming unchanged household sizes – to an additional demand for around 130,000 primary residences by 2030.

Land use

According to the Federal Environment Agency, the total land use in Austria in 2021 was 41 km² per year on a three-year average, which corresponds to the size of Eisenstadt (capital of Burgenland). On average over the last three years, 11.3 ha of new land was thus taken up per day (Umweltbundesamt, 2023). In Table 17, the sector-specific values for 2021 are given.

Table 17: Land use by sector

Sector	Annual increase in land use in 2021
Construction areas	21.1 km²/year
Roads	4.4 km²/year
Operating areas	11 km²/year
Recreation and quarrying areas	0.7 km²/year

Source: Own representation according to Federal Environment Agency (2023)

Although land consumption has thus decreased compared to previous years, it is still far too high in view of the targets set out in the government program. The program states: According to the government program 2020–2024, land consumption is to be kept as low as possible and the annual increase is to be reduced to 2.5 ha per day or 9 km² per year by 2030 (Umweltbundesamt, 2023). Table 17 shows that building land has the greatest reduction potential. This further reinforces the high priority given to the renovation of existing buildings for energy reasons.

Building stock

Status quo of the building stock

The building and housing register of Statistics Austria (2022a) lists as of 1.11.2022 around

- 2.6 million buildings (of which about 90% are residential) and
- 6.3 million usage units (of which 4.9 million apartments).

About 45% of housing units are in single-family homes, 52% are in multi-family buildings, and 3% are in non-residential buildings (Anderl, et alii, 2019). See also Chapter 4.1.

Increase in the building stock – new construction

According to the Third Building Culture Report (Baukulturreport; Bauer, et alii, 2017), there was the following increase in buildings and apartments in the period 2001–2011:

- 7% more buildings
- 11% more detached and semi-detached houses
- 15% more apartments

According to preliminary results from Statistics Austria, around 71,200 apartments were built across Austria in 2021. This exceeded the level of the two previous years by 5% in each case, or roughly 3,200 apartments, and recorded the highest result since the early 1980s. Twenty-three percent of all completed apartments in 2021 were built with new construction in Vienna, followed by Upper Austria (about 19%), Lower Austria (17%), and Styria (more than 14%). The share of newly built apartments was around one-tenth in Tyrol, one-twentieth in Salzburg, around 4% each in Vorarlberg and Carinthia, and 3% in Burgenland. In Vienna, the disproportionately high value in multi-story residential buildings is striking, as expected. In 2021, almost 38% of all apartments of this building type were created in the federal capital alone.

In the case of single and two-family houses, the province of Lower Austria followed by Upper Austria had the highest share at 26% and around 23%, respectively (Statistics Austria, 2022b).

Drivers of the momentum in new construction have been the increase in personal living space, the increase in single households, population growth, and the investment of money in real estate due the European Central Bank's low interest rate policy in recent years (compare Struber, 2019; Amann, Goers, et alii, 2021).

Building stock – refurbishment

Subsidized and privately financed, deep renovation and cumulative individual measures totaled just over 1.5% of the building stock (main residences) in 2020. The renovation rate has thus stagnated at more or less the same low level of around 1.5% since 2015. The current government program of January 2020 includes the goal of increasing the renovation rate to 3%. This is to be achieved through federal funding initiatives, the further development of housing subsidies by the provinces, the introduction of a socially acceptable renovation requirement, and funding programs for the thermal-energy renovation of commercial buildings (Amann, Mundt, et alii, 2021). A different approach is taken by the study Wärmezukunft 2040 (Heat Future 2040) conducted by the Federal Environment Agency (BMK, no date), which shows the required level of renovation activities, the necessary extent of energy source change, and the quality of new construction to be achieved in order to decarbonize the building stock by 2040 (compare Table 18).

Table 18: Results residential and tertiary buildings, measures required to decarbonize the building stock by 2040

Indicator	Starting point 2018	Decarbonization 2030	Decarbonization 2040
Photovoltaik area	9 Mio	46 Mio.	77 Mio.
Construction standard, new buildings (heating demand in kWh/m2a)	60	26	26
Thermal renovation rate (% m² BGF/a)	3.8	4.9	4.4
Construction standard, renovation (heating demand in kWh/m2a)	59	57	48

Source: Own representation according to Wärmezukunft 2040, Dekarbonisierung der Wärmebereitstellung im Sektor Gebäude, Federal Ministry of Climate Action

The pre-1970 building stock (corresponding to 45% of the total residential floor area) is considered to have the highest potential for saving GHG emissions through thermal-energetic renovation. The residential building stock of the Gründerzeit in Vienna has a GHG emission share of 6% of the total Austrian residential building stock. Accordingly, residential buildings constructed before 1970 are of particular importance. In relation to the total number of buildings, about 1.3% represent a testimony of "historical, artistic or other cultural significance" according to the Monument Protection Act. The potential GHG emission savings from façade insulation in listed and culturally significant residential structures is about 1% of total emissions from residential structures (Henneberger & Steiner, 2022).

Outlook

Although the deep renovation rate showed a slight upward trend of 0.7% in the period under review (2008–2018), the target of a 3% increase by 2020 planned in the climate strategy for residential buildings was not achieved. Population growth, increasing residential floor space, and growing comfort needs have recently led to a strong surge in new construction of residential and service buildings, while renovation activities increased only slightly. This leads to a stabilization, but not to the targeted reduction of emission levels (Henneberger & Steiner, 2022).

With regard to demographics, population growth due to migration and growth in the proportion of people over 60 are determining factors with an impact on the development of the building sector (Bauer, et alii, 2017).

Labor force construction

Unemployment in construction

After the start of the pandemic in March 2020, unemployment in Austria also rose sharply in construction, and the number of people registered as unemployed did not fall back below the pre-crisis level of 2019 until November 2021. At the end of October 2022, the number was 473 people or 3.1% below the October 2019 level (AMS, 2022).

Distribution of employees by industry

About two-thirds of the employees in construction are in six economic classes. Most employees are counted in the building construction (23%), electrical installation (13%), gas, water, heating, and ventilation and air conditioning installation (13%), roofing and carpentry (7%), road construction (13%), and painting and glazing (6%) sectors (AMS, 2022).

Vacancies – shortage of skilled workers

At the end of October 2022, 8,595 immediately available vacancies in construction were registered with the AMS throughout Austria. This corresponds to a decline of 7.4% or 682 jobs compared to October 2021. However, if the comparison month of the pre-crisis year 2019 is taken into account, an increase of 30.5% or 2,010 jobs is shown. Across all industries, October shows job growth of +9.5% compared to 2021, or +61.2% compared to 2019. The most jobs to fill at the end of October were in building construction (18%), electrical installation (16%), gas, water, heating, and air conditioning installation (14%), and roofing and carpentry (10%) (AMS, 2022).

The shortage of skilled workers is now part of everyday life in many occupational groups. In the trade and crafts sector, for example, glaziers, painters, floor layers, tilers, and carpenters are among the occupations with the greatest shortages (Handwerk + Bau, 2022).

Outlook

Increasing the rate of refurbishment to the extent required by energy policy will lead to a worsening of the already existing shortage of skilled workers if no appropriate accompanying measures are taken. Conducted as part of the City of the Future program the study "Capacity adjustment of the construction industry for an increased renovation rate" (Amann, Goers, et alii, 2021) shows that in the past, with different developments in terms of sectors, there have always been shifts in production figures between building construction and civil engineering, and between new construction and renovation. This means that changes in the construction industry as a whole have been much smaller than changes in individual sectors. Any decline in the volume of new construction or existing declines in civil engineering would be offset by increases in building renovation. However, according to Amann, et alii (2021), if the order situation in new construction is sufficient, there is only limited interest in expanding activities in building renovation because new construction is economically more attractive to the construction industry than renovation for several reasons. These include larger construction lots and easier scaling, much higher potential for prefabrication and machine use, lower demand for craftsmanship among employees, lower personnel requirements, more easily definable service packages (including for subcontracting), and much lower construction risks (including warranty).

7.2.3 Scenario description and stakeholder feedback

Overview of the scenarios

The following parameters were assumed to be the same for both developed scenarios:

- Achieving the targets under the European Climate Act and the Austrian targets by 2030 with the following measures: promotion of the refurbishment concept[121] as a strategic instrument for deep renovation; zero-emission new construction; switch to renewable energy sources (heat pump, biomass heating, solar thermal and photovoltaics), and high-efficiency district heating in the building stock (compare Chapter 7.2.1)
- Population development and quantitative (number) and qualitative (size) demand for apartments
- Age structure and related housing and household forms
- Economic development: energy prices, disposable household income, subsidies, interest rate policy

Explanation of Scenario 1 ("Target focus 2030"):

Scenario 1 is based on the existing targets up to 2030 and aims to meet the commitment in the area of refurbishment rate and decarbonization in the energy supply of buildings. It assumes that the volume of new construction will continue to rise to meet the increasing demand for more living space, as companies generally prefer new construction to refurbishment. In any case, this means that it can be assumed that the additional demand for housing will be met by new construction, and that additional refurbishments will require additional labor.

In the field of renewable energies, the corresponding EU emergency regulation[122] is expected to accelerate expansion with corresponding consequences for labor requirements.

Explanation of Scenario 2 ("Target focus 2050"):

Scenario 2 takes European and national greenhouse gas reduction targets up to 2050 into account and is based on the assumption of a radical transformation of the economy. It not only meets the legal obligations in the area of clean-up rate and decarbonization, but also responds to other Green Deal requirements, such as the establishment of a circular economy in the area of material use and the conservation of natural capital. Among other things, it assumes that the strategic goals in the area of reduction of land use are actively demanded, resulting in the following effects in the building sector:

- Inner development and redensification (additions of stories, loft conversions, use of gaps between buildings and brownfield sites) of urban areas and town centers
- Land recycling: demolition and redevelopment of unused, outdated infrastructure that cannot be redeveloped at a reasonable cost

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[121] According to Article 10 Proposal for the new edition of the Building Efficiency Directive (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0802, retrieved on 23.02.2023): Renovation roadmap as part of the renovation passport. Approaches in this regard already exist in the form of the renovation concept as part of the Austrian Energy Performance Certificate (OIB RL 6 Energieeinsparung und Wärmeschutz 2015), as part of energy consulting, and as the klimaaktiv renovation roadmap (https://www.klimaaktiv.at/service/publikationen/bauen-sanieren/sanierungsfahrplan.html, retrieved on 23.02.2023).

[122] Council of the European Union 29.12.2022.

There will be a restriction on the volume of new construction and thus a shift in the workforce from new construction to refurbishment. This has a serious impact on the type and content of the necessary training and continuing education.

In the field of renewable energies, energy planning will be strengthened and optimal use will be made of the corresponding EU emergency regulation. This will result in a strong acceleration of the expansion of renewable energy systems with corresponding consequences for the demand for labor.

Table 19 shows the relevant influencing factors for the scenario generation and the respective expression for Scenario 1 and Scenario 2.

Table 19: Comparison of scenarios 1 and 2

Influencing factors / framework parameters	Scenario 1 "Target focus 2030"	Scenario 2 "Target focus 2050"
Meeting the demand for housing		
Additional apartments needed	Primarily new construction: zero-emission buildings	Above all, refurbishment: deep renovation that fully utilizes the energy saving potential
Urbanization (single-family houses in rural areas, apartment buildings in urban areas; where is being built/rehabilitated)		
Revitalization of rural areas through the expansion of public transport	No additional measures in the area of public transport expansion	Additional measures in the area of public transport
Soil protection policy		
Soil sealing due to new buildings and the development required for them (roads)	No additional measures for less land use	Reduction of new construction on unsealed surfaces
Energy space planning		
Priority areas for renewable energies in the zoning plan	No additional measures	100% operational: renewable energy projects are developed and commissioned on the increased number of designated priority areas or land specifically dedicated to certain renewable energy (RE) sources.
Technical developments		
Digitization and data	Building Information Modeling only for large commercial projects.	Additional measures are leading to Building Information Modeling becoming a common approach.

	Smartness or intelligence capability[123] of buildings only in some areas and in large commercial projects	Smart buildings ensure energy-efficient operation, provide feedback on energy consumption to users, and play an important role in stabilizing the power grid (grid efficiency).
Industrialization	Industrialized new construction, robotized construction sites	Refurbishment: especially for multi-family houses built up to 1980 using prefabricated components
PV as a strategic pillar of the EU	No additional measures	Additional measures lead to Integrated PV becoming a common approach (where appropriate due to irradiation)
Industry based on circular economy	No additional measures; essentially remains voluntary approaches in the area of building assessment	Measures to promote material efficiency, longevity, flexibility of use, maintenance reduction and reuse, recycling and recovery, life cycle assessments

"Story Building Sector Future"

For the stakeholder feedback, the essential elements and developments of Scenario 2 "Target focus 2050" were presented in a short, structured, and easy-to-read text description as "Story Building Sector Future". The story formed the basis for the workshop "The Future of the Austrian Building Sector". It is based on the assumption of a radical transformation of the economy and the building sector towards decarbonization and refurbishment, taking into account national and European greenhouse gas reduction, renewable energy and energy efficiency targets, as well as other aspects of the Green Deal, and is divided into five development fields:

1. Meeting the demand for housing

Demand for housing is on the rise. The reasons are the influx to Austria, the increase in single-person households, and the rising living space per person. New construction activity on unsealed land is severely limited. Demand is largely met by deconstruction of existing buildings and new construction of zero-emission buildings, as well as comprehensive and in-depth renovation and densification of existing substance. Developments in the area of digitization allow for the increased use of home office models. Families with small children in particular are settling in revitalized and densified settlements in rural communities.

2. Urbanization versus revitalization of rural areas

This also applies to adults who value the rural area and no longer move to the cities for training or work, but commute. This is possible because service providers in the field of

[123] Intelligence capability indicator: https://eur-lex.europa.eu/legal-content/DE/TXT/HTML/?uri=CELEX:32020R2155&from=PT, retrieved on 23.02.2023

building renovation are developing an offer that is well received by the population. In the area of public transport, solutions have been established for those sections of the route that are not covered by rail.

3. Land consumption

The progressive increase in land sealing has been found problematic, and effective instruments are in place to reduce additional land sealing. As a result, there is an incentive to redevelop the building stock and – if possible – to increase density. This development supports municipalities in their efforts to revitalize town centers.

4. Energy space planning

The role of the municipalities is upgraded. They translate requirements of state laws into local concepts that have the population's acceptance and anchor the corresponding strategies in their local development concepts. This applies above all to the areas for the expansion of renewable energy systems. Through the optimized interaction of the state and municipal levels, the potential for renewable energy can be fully exploited through appropriate project developments and commissioning.

5. Technical developments

This applies above all to the expansion of photovoltaics (PV), which is being carried out in parallel with or in coordination with the renewal of the power grids by combining it with suitable control and regulation technology and appropriate storage technologies. Even more efficient and cost-effective systems and new PV applications that can be integrated into the building envelope are being developed.

Advances in the field of digitization make it possible to map the natural and built environment as a data model. For the expansion of photovoltaics, the application of data models causes a simplified identification of potentials. For buildings, data models are created and kept up-to-date, providing valuable support in maintenance and continuous improvement. Building Information Modeling is becoming a common approach in the construction industry. Adapted models are also proving their worth in the small-volume segment and in the refurbishment of buildings. Building Information Modeling is also an important basis for realizing the requirements of the circular economy: material and energy efficiency as well as durability, flexibility of use, maintenance reduction and reuse, recycling and recovery. Among other things, information about materials and their properties is stored and makes targeted deconstruction and recycling in cycles possible.

In this context, the intelligence capability of buildings is also increasing. Sensible elements of the intelligence capability indicator (among others, ensuring energy-efficient operation, feedback on energy consumption to the occupants, stabilization of the power grid) are largely gaining acceptance and becoming standard.

The industrialization of refurbishment in the segment of multi-story residential buildings, built around 1960 to 1980, offers prefabricated, integrated components (for example, curtain wall with windows, ventilation systems, thermal solar systems and photovoltaic systems) that can be executed in a short time with few personnel.

The economic viability of a building refurbishment can be better illustrated by the industrialized prefabrication of elements and changed framework conditions for financing. In individual cases, 3-D printing offers solutions.

Results stakeholder feedback

Scenario 2 "Target focus 2050" was evaluated in a workshop with experts, practitioners, and stakeholders from the construction and real estate industry, education and training, and labor market research (for methodology, see Chapter 7.1). Participants had the opportunity to discuss concrete measures and developments for different topics of the future scenario under consideration (represented by the "Story Building Sector Future") and to give their assessment with regard to the necessity for achieving the objectives and the probability of implementation. The results of these workshop discussions are summarized below:

1. Meeting the demand for housing

Discussion based on the following guiding question: How do you think the demand for housing will be met in the future?

The development of neighborhoods with high building density and the reduction of personal living space are seen as essential measures to meet the demand for housing. Redevelopment projects are to be given clear preference over new buildings, and the creation of legal frameworks and regulations is considered particularly important. The prerequisite for this, however, is individual and societal flexibility, for example the willingness to use community facilities, acceptance of small apartments, and new usage scenarios for residential buildings due to changing living and working conditions, as well as reduction of comfort requirements (for example, with regard to space heating, appliance usage, et cetera). The likelihood of future realization of reduced individual and increased shared housing as well as the preference for rehabilitation over new construction, however, is considered low. There is also a lack of awareness of sustainability issues, which are still inadequately taught through current curricula in education and training.

2. Urbanization versus revitalization of rural areas

Discussion based on the following guiding question: In your opinion, which offers in the field of building renovation will be available in rural areas?

For the revitalization of rural areas, redensification, the creation of affordable housing, the use of vacancies, but also the establishment of businesses and the creation of local employment opportunities are seen as essential prerequisites. In addition, sustainable mobility concepts and the availability of services such as schools, local supply, et cetera are seen as important development parameters. The targeted promotion of redevelopment as well as creative freedom of action in the redevelopment/transformation of listed buildings are significant in this respect. Obstacles to the implementation of necessary measures are due to the lack of spatial planning expertise among actors and stakeholders. Furthermore, ownership structures and the tension between individual property and social development potentials are barriers to the implementation of measures.

3. Land consumption

Discussion based on the following guiding question: What areas do you think will be available for new buildings in the future? (How much and where?)

Parking lots and building superstructures and additions will represent an important usable area potential for new buildings in the future. According to the workshop participants, new land sealing will continue to take place, especially in urban areas, due to the demand for housing. In addition to technical solutions, legal and (subsidy) political framework conditions will therefore be necessary to activate space and land reserves, especially in existing structures, and to limit further land sealing. In addition, specialists will play an essential role in coordinating different interests. The basis for the implementation of the upcoming measures is awareness raising and flexibility to establish a changed living culture.

4. Energy space planning

Discussion based on the following guiding question: Which renewable energy systems do you think will be expanded more, and in which regions?

Local heating from waste heat, ambient heat, and geothermal and solar thermal energy – in contrast to biomass, whose security of supply is in doubt – will represent an important pillar in building energy supply. Combinations with building-integrated PV systems also represent important solutions, with self-consumption optimization in the foreground. At the same time, large-scale and agro-PV systems are seen as pure feed-in plants. Due to a lack of social acceptance, wind energy is attributed only minor importance in the expansion of renewable energy systems. Professional support in planning and implementing measures, energy management, and monitoring are seen as key challenges, for which trained personnel will be necessary.

5. Technical developments – power supply

Discussion based on the following guiding question: How do you think we can achieve a stable power supply based on renewable energy?

Regionalization of the power grid is necessary for a stable power supply. The formation of energy communities, interacting data models, and decentralized electricity storage facilitate load sharing. In principle, the production of PV panels in Europe is considered desirable, as is the creation of legal frameworks to enable access to PV electricity for individual consumers, for example in multi-family dwellings. Bottlenecks in the availability of suitable land, manpower but also technologies for communicating systems are seen as key challenges. There is a need to raise awareness among planners and homeowners, but also to integrate content on renewable electricity supply in the general education system.

6. Technical developments – circular economy

Discussion based on the following guiding question: How do you think we achieve the circular economy in the building sector?

Economic aspects are central criteria for the implementation and application of circular economy in the construction sector, for which corresponding support instruments are necessary. The EU Taxonomy Regulation is seen as an effective instrument in this respect. In the sense of circular economy and resource efficiency, planning should be done in such a

way that parts and components are kept in use as long as possible, and that they are repairable or replaceable as well as separable and recyclable. The development and availability of databases on the construction materials used and their properties are seen as an important prerequisite for the implementation of recyclable construction methods. However, current standards and regulations stand in the way of the implementation of a circular economy and must therefore be adapted. Criteria also need to be defined in the area of tendering and contracting so that circular economy principles can be applied. The shortage of skilled workers in the construction industry, especially in the field of renovation, and the high demand for further training in connection with recyclable materials and construction methods represent an additional challenge.

7.2.4 Gap analysis and stakeholder feedback

In addition to desktop research, the gap analysis is primarily based on the competence analysis of the existing education and training system carried out by the project team (see Chapter 5.4), as well as the results of the stakeholder workshop (see Chapter 7.1). Taking into account the developed target definition for the national qualification roadmap to be developed for education and training (compare Chapter 5.1.3), the analysis was divided into three thematic areas. The results are presented in the following chapters.

Energy efficiency, use of renewable energy, and zero-emission new construction

Relevant competences in education and training

The teaching of competences for increasing energy efficiency and the use of renewable energies in the building sector, as well as for establishing zero-emission buildings, is overall already well anchored in curricula and syllabi across all education sectors or well covered by existing continuing education programs. A detailed presentation of the analysis results can be found in Chapter 5.4.8 (see Table 13).

Relevant fields of action and need for qualification

Table 20 shows the relevant fields of action identified by the project team for various groups of actors in connection with the establishment of zero-emission buildings, for which a need for qualification is seen in principle.

Table 20: Identified fields of action in connection with the establishment of zero-emission buildings for different groups of actors

Stakeholder groups	Housing sector		Non-residential buildings
	Single-family homes	Apartment buildings	
Authorities	Energy planning (priority areas for certain renewable energy systems, connection obligations, decarbonization of district heating and cooling)		
Industry (manufacturers of products, components, parts)	Product development in the field of renewable energy systems, storage systems, window technology including daylighting and prevention of summer overheating, insulation		

Planning	Optimized concepts prefabricated house	Life cycle-oriented planning, consulting service architecture, et cetera
	Planning for self-consumption optimization of PV electricity	Planning for self-consumption optimization of PV electricity
Construction	Integration of building envelope and renewable energy system, installation of control and regulation technology, user feedback	
Management and operation	Control and regulation technology, user feedback for energy consulting	Control engineering, user feedback for facility management
Financing	Sustainability criteria in real estate and risk assessment for banks	Sustainability criteria in real estate and risk assessment for investors, such as insurance companies, funds, et cetera
End customers / clients	Advantages of zero emission buildings, proper ordering, proper use	

In the course of the workshops conducted, a need for qualification was seen for the increase of energy efficiency and the use of renewable energies, as well as for the establishment of zero-emission buildings, in particular with regard to the following topics (according to groups of actors):

- **Planning:** A particularly high potential for achieving the energy and climate targets in the building sector was seen in the communication of basic principles for site and climate-appropriate planning.
- **Management and operation, end customers, clients:** A high impact potential as well as an existing need for training and continuing education was seen in connection with competences for the efficient operation of complex building services equipment and systems.

Skilled labor requirements

With regard to skilled workers, the workshops identified a challenge in the existing shortage of qualified specialists for the planning and installation of photovoltaic systems. A recent study by the Austrian Energy Agency (Thenius et al., 2023) estimates a labour requirement (in full-time equivalents) of 7,066 people (3,140 electricians, 3,140 auxiliary staff and 786 planners) in order to achieve the target of 11 TWh of additional electricity production from photovoltaics per year set out in the Renewable Expansion Act (Erneuerbaren-Ausbau-Gesetz – EAG), although it can be assumed that a large proportion of the identified demand for electricians and auxiliary staff is not currently available on the labour market. For the expansion of wind power (construction, dismantling, maintenance and service), Thenius et al. (2023) assume an additional need for 1,300 workers by 2030.

A shortage of skilled workers in the field of building services engineering has been a recurring theme in the industry for years (compare Wechselberger, 2023).

In a company survey conducted in March/April 2022, Dornmayr and Riepl concluded that the overall shortage of skilled workers in Austria was at an "all-time high" (at least since the 1950s). By means of extrapolation, the study determined an estimated Austria-wide shortage of skilled workers (vacancies) across all sectors of about 272,000 persons based on all member companies of the Austrian Federal Economic Chamber (Dornmayr & Riepl, 2022, page 17). Among the occupational groups particularly affected by the shortage are skilled trades in general, but also occupations in the field of electronics/electrical engineering as well as installation and building services engineering (Dornmayr & Riepl, 2022, page 38–39). The companies surveyed as part of the study predominantly assumed that the shortage of skilled workers in their industry would increase sharply in the next three years (Dornmayr & Riepl, 2022, page 35 and the following).

Increasing the rate of refurbishment and decarbonizing the building stock

Relevant competences in education and training

The transfer of skills for carrying out comprehensive building renovations and decarbonising the energy supply in existing buildings is only partially anchored in the curricula and syllabuses of most education sectors. This area of competence is relatively well covered in the analysed curricula of building craftsperson and industrial master schools, as well as by the existing offerings in the field of continuing academic education. Particularly in the area of continuing vocational education and training, a clear potential for improvement is recognized in this field. The results of the detailed analysis are presented in Chapter 5.4.8 (see also Table 14).

Relevant fields of action and need for qualification

The following table shows the relevant fields of action identified by the project team for various groups of actors in connection with increasing the rate of comprehensive thermal-energy refurbishments (with the long-term goal of zero-emission buildings) and decarbonizing the energy supply in the building stock, for which a need for qualification is seen in principle.

Table 21: Identified fields of action related to increasing the renovation rate and decarbonizing the building stock for different stakeholder groups

Stakeholder groups	Housing sector		Non-residential buildings
	Single-family homes	Apartment buildings	
Authorities	Energy space planning; renovation concept (correct sequence of renovation measures to avoid lock-in effects); determination and assessment of greenhouse gas potential based on life cycle emissions of buildings, understanding and capability to interpret environmental product declarations (EPD)		
Industry (manufacturers of products, components, parts)	Energy service provider: project development for large-volume refurbishments (aggregation of projects)		

	Minimization of the greenhouse gas potential of materials, environmental product declarations (EPDs), development of products for serial refurbishment	
Planning	Energy consulting with renovation concept: measures in the area of building envelope and building services engineering for different building types, material recommendations based on life cycle assessments and EPDs	
	Refurbishment planning as a consulting service of specialist planning: measures in the field of building envelope and building services engineering for different building types, material recommendations based on life cycle assessments and EPDs	
Construction	Craft: correct installation of products, systems and prefabricated elements; recognizing interactions between products and systems; for different building types	
Management and operation	Implementation of the refurbishment concept with the support of energy consulting	Implementation of the renovation concept in accordance with the activity profile of property management/facility management
Financing	Sustainability criteria in real estate and risk assessment for banks	Sustainability criteria in real estate and risk assessment for investors such as insurance companies, funds, et cetera
End customers / clients	Advantages of comprehensive thermal-energy renovation, correct ordering, correct use; topic of heating replacement without renovation of the building envelope: what are the disadvantages; evaluation of materials: what do product evaluations say, how are they to be interpreted	

In the workshops conducted, the following topics in particular were seen as important for increasing the rate of deep renovations and decarbonizing the energy supply in the building stock (by stakeholder group):

- **Authorities:** Competences were discussed in connection with existing legal framework conditions (tenancy law, residential property law, et cetera) for comprehensive refurbishments as well as possible incentive systems for vacancy activation. A need for qualification was seen above all in the area of communication – for example, when it comes to demonstrating the advantages of renovation – as well as in the area of assessing the greenhouse gas potential based on life cycle emissions of buildings. As to decarbonization, the production of materials and associated greenhouse gas emissions should also be considered.
- **Industry (manufacturers of products, components, parts):** A need for qualification was identified above all for multi-story residential construction in connection with serial refurbishment.
- **Planning:** Competences for communication and consulting were seen as particularly important, especially in connection with life cycle costs, life cycle greenhouse gas emissions (CO_2 balance), possible "decarbonization paths" and renovation concepts (prioritization and possible sequence of renovation measures), as well as sustainability aspects in the building life cycle as a whole. In the workshops, the target group-oriented consulting of clients and property owners by planners was considered a particularly effective measure; at the same time, a high need for qualification was seen in this area. A need for qualification in the area of planning was also seen in connection with

competences for ecological and economic life cycle considerations as well as the use of passive cooling systems (cooling was identified overall as an increasingly important topic for qualification). Other competences needed are the development of strategies for vacancy utilization (including the conversion of non-residential buildings for the creation of living space) and the implementation of inventory analyses (recording the overall situation) prior to the planning and implementation of renovation measures.
In the area of building services planning, a need for qualification was identified in connection with the optimization of heat supply in existing buildings.

- **Construction:** A need for qualification was seen here especially in connection with the use of ecological building materials and the consideration of the gray energy of the materials used.
- **Management and operation:** The workshop participants saw particular potential in the employees of property management companies, as they are familiar with the buildings they manage. They should therefore be kept up to date with the latest technology through target group-oriented information and training programs.
- **Financing:** In the area of single and two-family houses, competences in connection with subsidies were considered important. For multi-story residential buildings, the need for qualification was seen in connection with risk assessments and life cycle considerations.
- **End customers / clients:** For end customers, the topic of environmental education and energy consulting was identified as highly relevant, granting this group of people access to knowledge about the legal framework, financial aspects (funding opportunities, life cycle costs, amortization, et cetera), and possible renovation concepts (concrete roadmaps/sequence of renovation measures).

Skilled labor requirements

With respect to the need for skilled professionals to achieve the goals of retrofitting and decarbonizing the building stock, the following topics were addressed during the stakeholder workshops:

- In addition to the necessary specialists in the areas of planning, execution, and operation, appropriately qualified specialists will also be needed who can mediate between the different interests, for example between owners and residents, or coordinate thermal-energetic renovations (for example, in the case of apartment buildings).
- A "vacancy survey specialist" could determine where there is potential for land use. According to the assessment of the workshop participants, there is not enough comprehensive information about already built-up areas that could be assigned to a new use.
- The workshops also identified a need for professionals with technical backgrounds and coordination skills to deal with the interface between existing buildings and building additions or expansions.

- In addition, specialists are needed to raise awareness among the population that thermal refurbishment and the switch to renewable energies are necessary to achieve the energy and climate targets. Various information channels need to be established here.

In the course of the workshops, the general shortage of specialists and workers in the construction industry, which particularly affects the field of refurbishment, was discussed several times. One workshop participant put it this way:

> *"The current shortage of skilled workers in new construction is high, and it's even higher in renovation!"*

An estimate of the size of the additional workforce required in the construction sector because of an increase in the renovation rate was provided in a 2021 study by Amann, et alii. The authors conclude that, depending on developments in the new construction sector, a "rapid sharp increase in the renovation rate"[124] in the period 2020 to 2040, which is necessary to achieve the energy and climate targets, would result in a rise of additional jobs throughout Austria. They assume an increase of 22,000 jobs (i.e. labour force, but not full-time equivalents) with a slight decline in new construction and an increase of 20,000 jobs with a moderate decline in new construction (Amann, Goers, et alii, 2021, page 37 and 54 and the following).

The study takes into account the effect evident from production figures that in the past there have always been shifts between building construction and civil engineering or between new construction and refurbishment, with developments in the construction industry differing from sector to sector. The changes in the construction industry as a whole were much smaller than in the individual sectors (Amann, Goers, et alii, 2021, page 43). Thus, it can be assumed that a decline in the volume of new construction or civil engineering would be offset by increases in building renovation. However, Amann, et alii also emphasize that if the order situation in new construction is sufficient, there is only limited interest on the part of companies in expanding their activities in building refurbishment.

Thenius et al. (2023) explore in their study the classification of workforce requirements for achieving key objectives of the energy transition for the comprehensive thermal refurbishment of residential buildings by 2040, estimating an annual need of just under 9,300 full-time equivalents. The greatest labour demand, significantly over 50%, is for individuals with at least a skilled worker qualification (NQR4 and higher), while about one-third is for semi-skilled workers, and the remainder for unskilled workers (<NQR4). In terms of trades, facade and scaffolding construction account for over 50% of the workload, followed by window construction, which plays a crucial role, especially in the refurbishment of multi-storey residential buildings (Thenius et al., 2023, p. 7f). The authors estimate that about half of this number (4,600) would be required in addition to the current workforce in the construction sector, assuming they are not reallocated from other building activities. For the targeted replacement of all oil heating systems in the existing building stock by 2035, Thenius et al. conclude an annual need of approximately 4,000 full-time equivalents (depending on the

[124] The scenario is based on the following assumptions: the rate of comprehensive refurbishment doubles by 2025 and increases to 1.4% by 2030. In the late 2020s, a total refurbishment rate of 2.5 and in 2040 of 3% is achieved, which means that the thermally insufficient housing stock would be completely refurbished by 2040.

proportion of installed heat pumps, around 3,300 installers, 400 electricians, and 300 planners), anticipating a significantly increased demand for labour (especially installers and electricians).

The industrialization of construction (among other things through a higher degree of prefabrication) and the associated shift of value creation from the construction site to the factory is seen as an opportunity to replace the use of personnel with the use of capital and thus to counteract the shortage of skilled workers (Amann, Goers, et alii, 2021, page 68). During the workshops held, possible advantages and disadvantages of industrial or traditional/handicraft reorganization were discussed. Approaches to industrial remediation, however, were seen by some discussants as only "part of the solution" because they are material and transport-intensive and are equivalent to "partial new construction." The discussion also emphasized that, to date, there is no evidence of a cost advantage of industrial over traditional remediation. However, according to the workshop participants, more well-trained personnel are needed for traditionally performed remediation.

Resource efficiency & recyclability

Relevant competences in education and training

The analysis of curricula and syllabi for content related to resource efficiency and circularity reveals a nuanced picture. Across all educational sectors, subjects and teaching contents on topics such as the energetic and ecological assessment of buildings, life cycle assessment, construction ecology, ecological building materials, or ecological construction evaluation are found. It is assumed that in all examined areas, basic competences for the examination and optimization of greenhouse gas emissions through the assessment of greenhouse potential are also imparted. Whether and to what extent the entire building lifecycle is considered in the teaching content, or whether considerations remain limited to individual lifecycle phases (construction, operation), cannot be sufficiently judged based on the analyzed documents. Given that the importance of lifecycle thinking and the related need for qualification – both in terms of life cycle cost analysis and ecological life cycle analysis – were emphasized several times during the workshops conducted, it is presumed that there is also potential for improvement in education and training.

Teaching contents related to circular construction and resource efficiency are only very sporadically found in the analyzed curricula and syllabi. The imparting of competences related to the transition to a circular economy is most likely anchored in the tertiary education sector and in professional development programmes. The detailed results of the analysis are presented in Section 5.4.8 (see especially Table 15).

Relevant fields of action and need for qualification

The following table shows the relevant fields of action identified by the project team for various groups of actors in connection with increasing resource efficiency and transforming the building sector toward a circular economy, for which a need for qualification is seen in principle.

Table 22: Identified fields of action in connection with increasing resource efficiency and recyclability in the building sector for different stakeholder groups

Stakeholder groups	Housing sector		Non-residential buildings
	Single-family homes	Apartment buildings	
Authorities	Topic area supporting innovation: advancing the state of the art; how innovative solutions are evaluated; how risks are managed; advantages in the approval process for innovative solutions		
Industry (manufacturers of products, components, parts)	Eco-design in product development, material passport as part of BIM		
Planning	Optimized concepts for precast house industry, material passport as part of BIM	Life cycle-oriented planning, consulting service architecture, et cetera; material passport as part of BIM	
Construction	Craft: correct installation of products		
Management and operation	Energy consulting extended to materials	Life cycle-oriented procurement in facility management	
Financing	Sustainability criteria in real estate and risk assessment for banks	Sustainability criteria in real estate and risk assessment for investors, such as insurance companies, funds, et cetera	
End customers / clients	Benefits of resource efficiency and recyclability; proper ordering; proper use		

In the course of the workshops, the following topics in particular were identified as requiring further training in order to increase resource efficiency and recyclability in the building sector (by stakeholder group):

- **Industry, design, construction, and operation:**
  - The workshop participants saw a particularly urgent need for qualification and at the same time a high impact potential with regard to the achievement of circularity in the building sector in the area of "interface knowledge". Examples mentioned in this context were interfaces between executing trades in construction, between different planning and technical disciplines, and between the building life cycle phases (for example, planning, construction, and building operation). In the opinion of the discussants, working and learning across disciplines and trades should be pushed more strongly in all areas.
  - Competences related to the development of conversion and deconstruction concepts, life cycle cost considerations, and sustainable building materials were seen as particularly important.
  - Overall, education and training for the building sector called for a greater focus on life cycle thinking and consideration of environmental costs (for example, for greenhouse gas emissions).
- **Planning:**

  - Knowledge related to the separability of structures and separate building functionalities (supporting structure, building envelope, interior finishes, and technical equipment) was seen as a prerequisite for the development of durable buildings, products, and components, as well as for the recyclability of the materials used.
  - In the area of design of multi-story residential and non-residential buildings, competences for increased use of Building Information Modeling and integral design were also cited as essential.

- **Construction:** The integration of basic knowledge and competences on the topic of sustainability and circularity in apprenticeships, relevant vocational schools, and master craftsperson qualifications was seen as an important lever for the transformation towards a circular economy.

- **Financing:** Aspects of economic efficiency were considered a decisive criterion for the implementation of the circular economy. The EU Taxonomy Regulation was assessed as an important and effective instrument in this context. Knowledge of the requirements for the circular economy according to the EU Taxonomy Regulation was therefore considered particularly important and urgent for the area of financing, but also for all other groups of actors.

Skilled labor requirements

With regard to the need for qualified specialists to achieve the goals in the area of resource efficiency and recyclability, the current shortage of specialists in the construction industry was also addressed in the stakeholder workshops. A general need for further training was seen in connection with recyclable construction methods and the use of recyclable materials and components.

A need for qualified specialists was also seen, in particular to create the organizational prerequisites for the transformation to a circular economy. Examples given were the necessary adaptation of the legal and normative framework, the collection and provision of necessary data (for example, in the form of material databases, material passports, et cetera), and the development and implementation of appropriate business models for the circular economy in the building sector.

8 Barriers and opportunities

8.1 Methodical procedure

As a basis for the development of the national qualification roadmap, a SWOT analysis was started in the last sub-step. The aim of the SWOT analysis is to identify strengths, weaknesses, opportunities, and threats of the current status quo, which are related to the qualification of professionals in the building sector and have the potential to promote or hinder the achievement of the energy and climate targets in this sector.

The project team collected strengths and weaknesses (influencing factors within the system under consideration) as well as opportunities and threats (external influencing factors and developments in the environment of the system under consideration) in a table that have a potential impact on achieving the defined objective[125] of the qualification roadmap. The basis for this was the results on the current status of the energy policy and legal framework (Chapter 3), the analysis of the building sector (Chapter 4), the existing framework conditions in education and training (Chapter 5), the evaluation of the first national roadmap (Appendix II: Providers and offers in the area of continuing vocational training), as well as results from the conducted workshops (Chapter 7). This resulted in over two hundred entries in total, which were then clustered and sorted thematically in team workshops, enabling the identification of key topic areas for potential barriers and opportunities. The SWOT analysis was still in progress at the time of finalizing this report. Initial results in the form of key thematic areas and fields of action are presented in the following chapter.

8.2 SWOT analysis of identified topics

8.2.1 Education and training offers

Strengths

- Overall, there is a wide range of formal qualifications in Austria that relate either directly or indirectly to the building sector. In the formal qualification system, there are not only offers for young people, but also (mostly as evening or vocational format) offers for adults (for example, schools for industrial master and building craftspersons, post-secondary VET and add-on courses), which build on existing qualifications.
- Training programs in the vocational school system (especially in secondary schools) lay a broad foundation that enables graduates to pursue a wide range of professions and specializations.

[125] Compare target definition in Chapter 5.1.3: "The aim of the roadmap is to ensure the necessary competences (skills) for achieving the national energy and climate targets in the building sector by 2030 (and beyond)."

- In the field of continuing professional development, there are a large number of actors and providers, as well as a wide range of training courses in different formats that address topics related to achieving the energy and climate goals in the building sector.
- Numerous offers of different continuing education formats related to the energy and building sector are also available in the field of scientific continuing education (see also Chapter 5.4).
- The klima**aktiv** initiative bundles advice, information (building database), further training, and quality assurance measures (building certification) for achieving the energy and climate targets in the building sector and makes them available to specific target groups.

Weaknesses

- Some target groups that play an important role in achieving the energy and climate goals in the building sector are currently not addressed or not sufficiently reached with appropriate offers for teaching relevant competences (see also awareness raising), these include:
  - Owners and users of buildings and real estate, who have a strong influence on the efficient operation of buildings and the implementation of energy efficiency and renovation measures
  - (Private) clients, who determine the demand for energy-efficient and sustainable construction methods, thermal-energetic renovations, and renewable energy systems, especially in the single-family housing sector
  - Property managers and caretakers, who have a strong influence on the efficient operation of buildings as well as on the implementation and quality of renovation measures
  - Actors in the field of public administration, financing, and insurances

Opportunities

- Cooperation between companies and research institutions for the development of customized qualification measures (see, for example, FFG qualification projects in Chapter 5.5.4) can contribute to the expansion and development of education and training offerings.
- The growing demand for qualified specialists for the building sector in emerging countries brings with it the opportunity for international education and training cooperation.

Risks

- Achieving the energy and climate targets in the building sector could be jeopardized due to target groups not being reached or not being reached sufficiently so far (see above "Weaknesses").

8.2.2 Mapping of relevant competences in education and training

Strengths

- A particular strength identified here is that the teaching of skills to increase energy efficiency and the use of renewable energies in the building sector is well anchored in relevant education and training programs across all education sectors.
- Competences for the consideration and optimization of greenhouse gas emissions over the life cycle of buildings are also well represented in the area of education from NQF level 6 and in continuing education.
- In the area of apprenticeship training, learning objectives for sustainable work (environmental protection in the company, waste separation, resource-conserving work) have been defined as standard for all newly updated or newly introduced occupational profiles in the competence area "Quality-oriented, safe, and sustainable work" since 2020, with specific tailoring to the respective occupational area.
- In the field of professional training, there is a large number of actors and providers, as well as a wide range of training courses focusing on energy efficiency and the use of renewable energies in buildings, the consideration and optimization of greenhouse gas emissions, and Building Information Modeling.
- In continuing education in science, there is a wide range of different continuing education formats that cover a broad range of the relevant competences studied (compare also Chapter 5.4).

Weaknesses

- Competences for increasing circularity and resource efficiency in the building sector are currently less well established across all education sectors. The same applies to competences related to increasing the renovation rate, such as competences for carrying out comprehensive building renovations (including through modular and industrialized solutions), for decarbonizing the energy supply in existing buildings, and for the energy modernization of historic (listed) buildings (compare Chapter 5.4).
- Competences in connection with cross-trade and cross-disciplinary cooperation in planning and execution, the use of participatory methods and intermediary support processes in planning and project development, and the optimization of building operation are currently also not sufficiently reflected in education and training.
- In the important areas of real estate and facility management as well as in the real estate industry, competences on the topics of energy efficiency, refurbishment, and recyclability are barely anchored in education and training (with the exception of individual offerings).

Opportunities

- In the area of vocational training, the amendment to the Vocational Training Act (BAG) 2020 introduced a statutory updating cycle of five years for job profiles in order to make

regular adjustments to job profiles in line with labor market-specific requirements and technical developments.

- Especially in the field of research and development, Austria has a high level of expertise in many of the relevant topics, and there are initiatives and instruments that help to bring the existing knowledge into continuing education (see Chapter 5.5.4).
- In the area of vocational education and training (especially in secondary schools), an opportunity is seen in specialization through discretionary topics of schools (in accordance with the framework conditions of the school law), as more and more schools are setting their priorities in the area of sustainable construction.
- The EU Taxonomy is seen as an important and effective tool to map and drive the cost-effectiveness of considering sustainability aspects, such as resource efficiency and circularity in the building sector. Furthermore, it is seen as a driving factor for raising awareness and embedding sustainability competences in the real estate and banking sectors.

Risks

- Risks related to the mapping of relevant competences in education and training are seen in the fact that workers cannot adapt to the changed working environment due to a lack of competences (for example, in the areas of remediation and circularity), thus jeopardizing the achievement of energy and climate goals.
- Another risk lies in the time lag between the occurrence of developments and events that result in changed requirements for competences in the building sector and the implementation of necessary adjustments in the education and training system or the effects thereof on the labor market. In the case of particularly rapid or unforeseen developments – for example, of technical, societal, economic, legal, or ecological nature –, there is a risk that it will not be possible to respond quickly enough by adapting teaching and learning content.
- In principle, sustainable action should be a cross-cutting issue in all professions. However, domain-specific content is also required, especially for the construction professions. There is a danger that these will be neglected or that curricula in general will be overloaded.

8.2.3 Education and training participation

Strengths

- In the field of vocational secondary schools, higher federal technical colleges (HTLs) have numerous trainings in subject areas that are directly and indirectly relevant to the construction industry. This applies in particular to the field of construction engineering, but also to areas such as electrical engineering and mechanical engineering.
- In the tertiary sector, a constant number of degree programs in the field of "Engineering, manufacturing and construction" (assignable to the ÖNACE 2008 classification of economic activities, code 7, construction/construction) can be observed over the past ten years (approximately 15% of all graduates; compare Section 5.2.2).

Weaknesses

- In the construction industry (according to the economic activity classification of ÖNACE 2008), there is a discrepancy between the development of the number of apprentices and the development of the number of employees. The WKO industry statistics show an increase of +20% in dependent employment for the construction trade association between 2015 and 2022. At the same time, the number of apprentices in the construction sector has only increased by around 5% in the same period after an interim decline. However, apprenticeship training is by far the most common form of qualification among employees in construction (compare Chapter 4.3.2).
- Compared to other sectors, in-service education and training participation in the building sector is low (compare Chapter 5.3.3 and Chapter 5.3.4).
- Across all education sectors, the share of women among education participants in the building sector is notably low (compare chapters 5.2 and 5.3). The only exceptions are individual educational programs, such as planning and administration-related apprenticeships, technical and commercial colleges, and architectural studies.

Opportunities

- Data show that in-company training activity is currently on the rise again and that more apprentices are being trained as a result. New apprenticeships (with a longer duration) offer the opportunity to raise the content of the training to a higher standard. An increase in the number of apprentices and thus of future professionals who are specifically trained for sustainability in the building sector can be pushed.
- The goal at EU level is to increase adult participation in continuing education from currently less than 40% to 60% by 2030. The series of initiatives[126] launched in this context is also seen as an opportunity to increase participation in continuing education in the building sector in Austria.
- Existing national initiatives and programs to make technical professions more attractive for women (see Chapter 5.5.3) are also seen as an opportunity to increase the proportion of women in education and training in the building sector.
- A great opportunity to increase participation in training and to make the building sector more attractive for various target groups was seen during the stakeholder workshops in the intensification and earlier start of career orientation, taking into account the strengths and weaknesses of students and greater involvement of parents.

[126] Among others, the following initiatives at European level can be mentioned: Recommendations on individual learning accounts and on micro-credentials; European Skills Agenda; Digital Education Plan; Council Recommendation on Vocational education and training (VET) for sustainable competitiveness, social fairness and resilience. This also includes the Council Resolution on the European Education Area, the Industrial Strategy for Europe, the SME Strategy, and the Commission Recommendation on Effective Active Support to Employment (EASE).

Risks

- One of the possible causes for the discrepancy between the development of apprenticeship numbers and the development of employee numbers in the construction industry mentioned in the workshops was the low social recognition ("image") of apprenticeships and skilled trades. The lack of attractiveness of such training programs is seen as a risk with regard to the future availability of qualified professionals.
- In the meantime, there has been a sharp decline in apprentices in the construction industry as increased labor demand has been met by foreign workers. Under certain conditions in the labor market, there is no feedback between company training activity and the demand for skilled workers. Moreover, the effect of increased training activity occurs only with a time lag.
- In the course of the workshops held, one of the risks associated with low participation in continuing education was that older actors, who are often also important decision-makers, are not up to date and do not have the necessary knowledge to implement projects that take sustainability aspects into account, due to a lack of regular continuing education and rapid developments.
- Possible causes for the low participation in in-service education and training in the building sector mentioned in the workshops include the difficulty of integrating it into everyday working life, financial obstacles, a lack of incentives for employees, a shortage of trainers, and high turnover rates among employees.
- Possible reasons for the low level of training activities in the area of in-company training were seen in the high fluctuation rate as well as in the already existing shortage of skilled workers in combination with a good order situation and thus high workload. The current shortage of skilled workers could be further exacerbated by increasing competition from other sectors. The currently highly volatile market developments and the resulting difficult forecasts in the construction and real estate sector were also mentioned in the workshops as obstacles to in-company training activities, as were the disadvantages feared by companies – for example, that more highly qualified employees leave the company after completing their training in order to become self-employed.
- Another risk is the lack of incentives for companies to invest in the in-company training for employees to acquire the skills required to achieve the energy and climate targets in the building sector, as they see no advantage in doing so due to the lack of demand from clients and the uncertain implementation of climate protection policy measures.
- Another risk associated with low participation in continuing education is that technology-based start-ups in the building sector could leave Austria because they cannot find suitably qualified employees here.

8.2.4 Framework of teaching and learning arrangements

Strengths

- The "triple training concept" represents a special feature and quality assurance in construction training. Construction academies (formerly, "Lehrbauhof"; literally: training construction yard) constitute a third learning site alongside the training company and the vocational school to which companies in the construction trade and industry send their apprentices. Here, additional qualifications are acquired and skills are taught that cannot always be covered in the company.
- In the area of construction, there have been a number of updates and the establishment of new apprenticeship occupations in recent years, resulting in greater specialization. In 2019, for example, the occupation of bricklayer was differentiated into the apprenticeship programs "Structural engineering" and "Structural engineering specialist" with a focus on new construction or renovation. The apprenticeship training "Building waterproofing technology" was newly established in 2019. In 2020, the apprenticeship training for real estate clerks was replaced by three programs with the same wording and different titles for property developers, real estate agents, and property managers.

Weaknesses

- In the course of the research carried out, it became apparent that there is no systematic overview of the entire range of education and training offered for the building sector. Likewise, there is currently no holistic monitoring for this education and training sector.
- The curricula, syllabi, and descriptions of educational offerings reviewed by the project team (see the competence analysis in Chapter 5.4) provide inconsistent information on teaching and learning content, making it difficult to survey and compare the competences currently being taught in detail.
- Processes for adapting and designing curricula and syllabi are relatively lengthy and in some cases non-transparent or unclear, which leads to long reaction times when competence requirements change.
- Inter- and transdisciplinary teaching concepts and methods are currently hardly implemented in training formats in the building sector.
- In the course of the workshops, several participants pointed to a shortage of trainers and teachers in some relevant areas of training and continuing education. Unattractive framework conditions and poor pay were cited as reasons for this.
- Existing lifelong learning (LLL) concepts do not seem to work in the building sector due to lack of appeal and conviction.
- Due to the current lack of a systematic survey of construction faults and structural damage (compare Chapter 4.2), not only is there no important fault analysis data for fault prevention, but also for didactic use in education and training (learning from faults in construction, positive fault and learning culture).

Opportunities

- An opportunity is seen in the integration of inter- and transdisciplinary methods in education and training programs throughout the building sector. This could not only impart relevant competences, but also increase acceptance and understanding of the importance of a socio-ecological transformation.
- The existing trend toward innovative teaching and learning methods also brings with it some opportunities, for example, through the use of digital technologies in teaching and learning settings, the trend toward micro-credentials, or the integration of existing MOOCs (massive open online courses) into educational offerings. Incorporating digital methods and tools as well as artificial intelligence into existing formats could increase the reach of education and training offerings in the building sector and make training more efficient.
- The trend towards competence orientation is seen as an opportunity to further develop curricula and make learning outcomes more visible.
- An opportunity to make the building sector more attractive for women is seen in stronger cooperation between schools and companies (for example, by using role models).
- Cooperation between science and schools (such as in the makingAchange project[127]) can help to further expand existing curricula and make technical professions and green jobs in general, but also in the building sector, more attractive to young people.
- Collaborations between companies and research institutions for the development of customized qualification measures (see for example FFG qualification projects in Chapter 5.5.4) can contribute to increasing participation in continuing education in the building sector.
- The growing demand for qualified specialists in the building sector in emerging countries brings with it the opportunity for international education and training cooperation.
- A great need, but also great potential was seen in the development of attractive and target group-specific concepts for lifelong learning during the workshops held.

Risks

- A possible risk in connection with the existing framework of teaching and learning arrangements is seen in the fact that innovative content might not make it into occupational profiles if they are not aligned with the training companies.

[127] As part of the project, the Climate Change Centre Austria (CCCA) together with the BMBWF invites all secondary schools to participate in the project "Climate Change and Sustainability" in Austria (https://makingachange.ccca.ac.at/en/was-ist-makingachange-english/, retrieved on 26.05.2023).

8.2.5 Raising awareness

Strengths

- Overall, society is seeing a trend toward slightly increasing awareness of the climate crisis, the need to reduce greenhouse gas emissions, and other sustainability issues such as land use.
- The instrument of energy consulting addresses important target groups, such as private clients and owners and (some) users of real estate. The renovation concept of energy consulting is a suitable instrument to plan and implement measures for deep renovation (improvement of the building envelope and subsequent conversion of the energy system to renewable energy sources) in the right order.

Weaknesses

- In the course of the workshops held, it was noted several times that the awareness of sustainability issues among the population and decision-makers is too low overall and that raising awareness more intensively should begin as early as elementary school.
- A lack of awareness of energy and environmental issues was seen among (private) clients, owners and users, and in the area of public administration.

Opportunities

- Media have an educational mandate and could contribute to raising awareness by giving climate neutrality a high priority in this context as well.
- Decision makers who have a good basic knowledge and understanding of problems going together with reaching the climate targets could participate more actively in the change.

Risks

- The necessary transformation of the building sector to achieve the energy and climate targets and the implementation of existing solutions requires acceptance among the general population. Without awareness of the need and understanding of the fundamental interrelationships, acceptance cannot be achieved.
- A possible risk in connection with awareness raising was seen in the fact that decision makers in the building sector have remarkably different educational backgrounds and it will be difficult to place relevant learning content in all training courses.

8.2.6 Labor market, industry specifics, and industry culture

Weaknesses

- In the construction industry, as in other sectors, there is currently a shortage of skilled workers in Austria. The occupational groups particularly affected include skilled trades in general, but also occupations in the field of electronics/electrical engineering as well as installation and building services engineering (compare Chapter 7.2.4).

- In addition to seasonal fluctuations in employment and unemployment figures, the construction industry is also characterized by a high turnover rate among employees.
- Compared to other sectors, there is below-average participation in continuing vocational training in the construction industry (compare Chapter 5.3.4), which indicates, among other things, a low level of continuing training culture in the sector.
- In the course of the workshops held, a "bad image" and a lack of social appreciation for craft professions and activities in the construction industry were mentioned several times.
- The work culture in construction is currently strongly male-oriented, and many occupations in the construction industry have "male" connotations in society's perception (for example, physically heavy and dirty work), making the industry rather unattractive to women.
- Despite the increasing complexity of planning and construction tasks, approaches such as integral or facilitated planning have hardly gained acceptance in the building sector so far.
- Participatory approaches and intermediary monitoring processes are often hindered by a lack of awareness, methodological competence, and high time pressure in the implementation of projects.
- At the interface between planning, where professionals with a high level of qualification tend to work, and execution, where mainly non-academic personnel are employed, the link is often missing in practice.

Opportunities

- An opportunity with regard to the existing demand for skilled workers is seen in the targeted addressing of women for occupations in the building sector. Breaking down traditional role models and occupational patterns in general can help to break down barriers that prevent women from taking up occupations in this sector.
- In the workshops held, a change in the general working conditions was mentioned as an opportunity to make occupations in the building sector more attractive. Aspects such as better pay and more flexible or shortened working hours ("four-day week") were discussed, as well as a more appreciative approach to employees in general.
- Developing career pathways for the construction industry – for example, for physically demanding jobs – was seen as an opportunity to keep workers in the industry longer.

8.2.7 Labor market policy instruments

Strengths

- Existing labor market policy instruments promote training and continuing education, particularly in the area of technical professions. Vocational qualifications can be upgraded here in line with demand.

Weaknesses

- In the past, the implementation, monitoring, and evaluation of some strategy papers (Green Jobs Master Plan, Lifelong Learning Strategy) have not been consistently pursued.
- Existing labor market policy instruments only occasionally refer specifically to the occupational area of green jobs (for example, environmental foundation) and not specifically to the building and energy sector.

Opportunities

- The Trade Regulation Act regulates which qualifications must be proven in order to carry out a trade. This can lead to quality standards being met. However, changes to the trade regulations can also control the demand for skilled workers (for example, by regulating who is allowed to install a PV system).

Risks

- Legal changes are necessary to adapt the trade regulations. This must be preceded by a political negotiation process, which may result in necessary changes not being made.

9 Conclusion

The aim of the European Climate Change Act, which came into force in June 2021, is to implement the European Green Deal by setting concrete targets for EU member states and to establish a legal framework for the main targets of "reducing greenhouse gas emissions by at least 55% by 2030 compared to 1990" and "achieving climate neutrality by 2050". In addition, Austria intends to achieve climate neutrality as early as 2040. The legal framework for reducing greenhouse gas emissions in the building sector is based on EU requirements and directives. It essentially covers aspects of building quality in new construction and renovation, heating and cooling strategy, and the use and generation of renewable energies.

In Austria, the building sector is responsible for about 17% of greenhouse gas emissions, making it the second most emitting sector after transport. Private households are also responsible for a high final energy consumption. The poor quality of the building envelope and energy losses during room conditioning as well as heat generation by burning fossil fuels are considered the main causes of increased energy consumption and greenhouse gas emissions.

Increasing per capita living space (especially the increase in the number and size of single-family homes), rising comfort requirements, and the associated increase in heating energy consumption are counteracting the successes achieved in other areas – such as the improvement of building envelopes and the use of modern heating technology. In recent years, this has led to a stabilization, but not to the targeted reduction in emission levels. A decisive energy-saving potential lies in the thermal refurbishment of the existing building stock. Nevertheless, thermal refurbishment and the replacement of fossil heating systems are only carried out to a limited extent in Austria.

Based on analyses of education and training for the building sector in Austria and discussions with experts, practitioners, and stakeholders on future scenarios related to the achievement of the energy and climate targets until 2030 and beyond, the present status quo analysis identified competence gaps and qualification deficits.

The analyses carried out show that the teaching of skills for increasing energy efficiency and the use of renewable energies as well as for establishing zero-emission buildings is already well established in all education sectors. Similarly, skills to improve the "intelligence" of buildings and in particular teaching content related to "smart buildings", building automation, regulation, and control technology are well covered in relevant technical education and training. However, digital competences to support the energy efficiency of buildings and Building Information Modeling (BIM) are not clearly anchored in training regulations and curricula in the area of apprenticeship training and in vocational middle and high schools. For the increase of energy efficiency and the use of renewable energies in buildings as well as for the establishment of zero-emission buildings, a need for qualification is seen in the area of planning, above all in connection with the development of design concepts that are suitable for the respective climate and location. There is also a need for education and training with regard to the sustainable management and energy-efficient operation of

buildings as well as for the operation of complex technical building systems. In the installation and building services engineering sector, a shortage of skilled workers has been pointed out for several years. Further personnel bottlenecks are identified in the planning and execution of photovoltaic systems, for example, as well as in the field of electronics and electrical engineering.

The teaching of skills for carrying out comprehensive building renovations is currently only partially anchored in the education sectors analyzed. There is a discernible need for development here, particularly in the area of continuing vocational training. Competences for the energetic modernization of historic (listed) buildings are barely or not at all included in relevant curricula and syllabi. Although monument protection, historic building constructions, and traditional building methods are thematic components of individual apprenticeships, courses of study, and academic continuing education courses, they are not associated with the increase of energy efficiency. Qualification needs for planning are also seen in the areas of inventory and vacancy analysis, ecological and economic building life cycle considerations, the development of conversion concepts, and in connection with consulting competences (for example, advising end customers/clients on the scope, sequence, and advantages and disadvantages of different renovation measures). For the construction sector, strategies to impart knowledge on the optimization of heat supply systems, material properties, and ecology of building materials are recommended. Technical knowledge on the efficiency of building services systems is also of central importance in the area of management and operation of existing buildings or renovation objects. This also requires qualified specialists to moderate the different interests of owners, residents, and other stakeholders and coordinate complex refurbishment processes.

In contrast to the teaching of competences in the field of building ecology, qualifications related to circular construction and resource efficiency are only included in isolated cases in curricula and syllabi. Competences related to the use of the level(s) framework are also addressed rather sporadically and mainly in the tertiary sector as well as in the field of continuing vocational education and training. However, the term "level(s)" is not explicitly mentioned in the analyzed curricula, syllabi, and offer descriptions. There is a need for qualification, among other things, against the background of the EU Taxonomy Regulation, which is relevant for all groups of actors. With reference to the areas of industry, planning, construction, and operation, interface knowledge and new planning and organizational principles are required, among other things. For example, material passes could be integrated into BIM planning tools to enable circular, life cycle-oriented planning and implementation, while at the same time supporting end customers as well as authorities, investors and insurance companies in the evaluation of sustainability criteria, degree of innovation, risk potential, et cetera.

Following the Roadmap to Education and Training of Skilled Workers in the Construction Industry from the implementation of the first national BUILD UP Skills initiative in 2013, numerous measures were proposed. These include the coordination of continuing training offers, cross-trade work, quality assurance in construction, personnel qualification for inspections of heating and air conditioning systems, as well as continuing training of teaching staff at vocational schools. Programs such as klima**aktiv** or the action plan Just Transition have taken up some of these proposals for measures (for example, by integrating climate-relevant

teaching content into existing courses and recommending that apprenticeship curricula be continuously updated and energy-relevant subject areas strengthened) and continue to do so. In addition, labor market policy programs are currently being implemented to promote education and training in technical and climate-relevant professions. Among other things, the aim is to qualify women for technical trades. With regard to measures for quality assurance in construction, however, it is clear that suggestions such as the establishment of quality officers have not been taken up in many cases. At the same time, there is currently an urgent need for action to record building damage and faults and the associated ecological and economic consequences systematically. It is also recommended to develop and apply instruments for the use of further training with regard to increasing the competence and professionalism of teaching and inspection personnel.

The broad range of formal qualifications across all education sectors and the already firmly anchored teaching of skills for increasing both energy efficiency and the use of renewable energies in buildings are seen as major strengths of the Austrian education and training landscape in the building sector. Other strengths of Austria's system is the consideration and optimization of greenhouse gas emissions. Even so, the focus here is heavily on individual life cycle phases and not enough on the entire life cycle. At the same time, skills and competences related to increasing circularity and resource efficiency, as well as increasing the rate of refurbishment and decarbonization of the energy supply in existing buildings are not yet sufficiently covered. There is also potential for development in teaching competences for cross-trade and cross-discipline collaboration in planning, construction, and operation.

The lack of attractiveness of skilled trades for certain target groups, the unbalanced gender ratio in the construction industry, but also the already existing high shortage of skilled workers represent possible barriers to sustainable developments in the building sector. In addition, the participation of professionals in continuing education and training is low compared to other sectors. This is explained, among other things, by the difficulty of combining (continuing) training activities with everyday working life, a lack of incentives, but also a lack of confidence in the implementation of climate protection policy measures (companies therefore see no advantage in investing in appropriate continuing education and training measures for their employees). Across all fields of development, it is clear that the creation of a legal framework, individual and societal willingness to change, and awareness raising and education at all levels are key factors for achieving the energy and climate goals.

The framework conditions presented in this status quo analysis – as well as identified strengths, weaknesses, opportunities, and threats – form the basis for the development of targeted strategies and measures in the field of education and training for achieving the energy and climate targets in the Austrian building sector.

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11 Literature

Amann, Wolfgang, Goers, Sebastian, Komendantova, Nadejda, & Oberhuber, Andreas. (2021). *Kapazitätsanpassung der Bauwirtschaft für eine erhöhte Sanierungsrate* (Projektbericht im Rahmen des Forschungs- und Technologieprogramms Stadt der Zukunft des Bundesministeriums für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (BMK). Nr. 2021/07; Berichte aus Energie- und Umweltforschung,). https://nachhaltigwirtschaften.at/resources/sdz_pdf/schriftenreihe-2021-27-kapazitaetsanpassung-bauwirtschaft.pdf

Amann, Wolfgang, Mundt, Alexis, Reiterer, Daniel, Schieder, Wolfgang, & Storch, Alexander. (2021). *Monitoring-System zu Sanierungsmaßnahmen in Österreich* [Im Auftrag der Verbände Gebäudehülle+Dämmstoff Industrie 2050, WKO – Fachverband Steine und Keramische Industrie, Zentralverband industrieller Bauproduktehersteller]. IIBW und Umweltbundesamt. http://iibw.at/documents/2021%20IIBW_Umweltbundesamt.%20Sanierungsrate.pdf

AMS. (2022). *Die Arbeitsmarktlage in der Bauwirtschaft: Spezialthema zum Arbeitsmarkt*. https://www.ams.at/content/dam/download/arbeitsmarktdaten/%C3%B6sterreich/berichte-auswertungen/Gesamtuebersicht_Spezialthema_zum_Arbeitsmarkt.pdf

Anderl, Michael, Bartel, Andreas, Elisabeth, Frei, Gugele, Bernd, Gössl, Michael, Mayer, Simone, Heinfellner, Holger, Heller, Christian, Heuba, Anna, Köther, Traute, Krutzler, Thomas, Kuschel, Verena, Lampert, Christoph, Miess, Michael G., Pazdernik, Katja, Perl, Daniela, Poupa, Stephan, Prutsch, Andrea, Purzner, Maria, … Zechmeister, Andreas. (2022). *Klimaschutzbericht 2022* (Band 0816; p. 260). Umweltbundesamt GmbH. https://www.umweltbundesamt.at/

Anderl, Michael, Bartel, Andreas, Geiger, Konstantin, Gugele, Bernd, Gössl, Michael, Haider, Simone, Heinfellner, Holger, Heller, Christian, Köther, Traute, Krutzler, Thomas, Kuschel, Verena, Lampert, Christoph, Neier, Henrik, Pazdernik, Katja, Perl, Daniela, Poupa, Stephan, Prutsch, Andrea, Purzner, Maria, Rigler, Elisabeth, … Zechmeister, Andreas. (2021). *Klimaschutzbericht 2021* (REP-0776). https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0776.pdf

Anderl, Michael, Geiger, Konstantin, Gugele, Bernd, Gössl, Michael, Haider, Simone, Heller, Christian, Ibesich, Nikolaus, Köther, Traute, Krutzler, Thomas, Kuschel, Verena, Lampert, Christoph, Neier, Henrik, Pazdernik, Katja, Perl, Daniela, Poupa, Stephan, Purzner, Maria, Rigler, Elisabeth, Schieder, Wolfgang, Schmidt, Günther, … Wiesenberger, Herbert. (2019). *Klimaschutzbericht 2019, Analyse der Treibhausgas-Emissionen bis 2017*. https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0702.pdf

Anderl, Michael, Gössl, Michael, Haider, Simone, Heinfellner, Holger, Krutzler, Thomas, Lampert, Christoph, Pazdernik, Katja, Perl, Daniela, Poupa, Stephan, Purzner, Maria, Schieder, Wolfgang, Schmidt, Günther, Schodl, Barbara, Storch, Alexander, Stranner, Gudrun, Wiesenberger, Herbert, Weiss, Peter, & Zechmeister, Andreas. (2021). *GHG Projections and Assessment of Policies and Measures in Austria* (Reporting under Regulation (EU) 525/2013

Reports Band 0766; p:. 184). https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0766.pdf

Bauer, Klaus-Jürgen, Bogensberger, Markus, Feller, Barbara, Hammer, Renate, Heindl, Gabu, Jaritz, Patrick, Kühn, Christian, Rihl, Bernhard, Schaffer, Hannes, Seiß, Reinhard, Temel, Robert, & Zech, Sibylla. (2017). *Dritter Österreichischer Baukulturreport: Szenarien und Strategien 2050*. https://www.baukulturpolitik.at/downloads/bkr-iii-langfassung.pdf

Bittersmann, Gerhard, Heschl, Thomas, & LandesEnergieVerein Steiermark. (2013). *Status Quo Bericht—Analyse Aus- und Weiterbildung in der Bauwirtschaft*.

BMB/BMWFW. (2017). *Strategie zur Validierung nicht-formalen und informellen Lernens in Österreich.* Bundesministerium für Bildung/Bundesministerium für Wissenschaft, Forschung und Wirtschaft.

BMBWF. (2022, Februar 22). *Fort- und Weiterbildung der Pädagoginnen und Pädagogen an berufsbildenden Schulen*. Bundesministerium für Bildung, Wissenschaft und Forschung. https://www.bmbwf.gv.at/Themen/schule/fpp/lfwb/bbs.html

BMK (Hrsg.). (o. J.). *Wärmezukunft 2040, Dekarbonisierung der Wärmebereitstellung im Sektor Gebäude*. https://www.bmk.gv.at/themen/klima_umwelt/energiewende/waermestrategie/waermezukunft2040.html

BMK. (2023). *Klimaaktiv.at*. https://www.klimaaktiv.at/

BMLFUW. (2016). *Masterplan Green Jobs—Mehr Jobs durch Green Jobs! Umsetzungsbericht 2015*. Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft.

BMNT. (2019a). *Integrierter nationaler Energie- und Klimaplan für Österreich, Periode 2021-2030 gemäß Verordnung (EU) / des Europäischen Parlaments und des Rates über das Governance-System für die Energieunion und den Klimaschutz*. https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/nat_klimapolitik/energie_klimaplan.html

BMNT. (2019b). *Langfriststrategie 2050—Österreich, Periode bis 2050*. https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/aktives-handeln/lts2050.html

Bundesgesetz, mit dem ein Bundes-Energieeffizienzgesetz 2023 erlassen wird und das Energie-Control-Gesetz geändert wird (Energieeffizienz-Reformgesetz 2023 – EEff- RefG 2023), (2022). https://www.parlament.gv.at/dokument/XXVII/ME/240/fname_1491772.pdf

Bundesgesetz über den Ausbau von Energie aus erneuerbaren Quellen (Erneuerbaren-Ausbau-Gesetz – EAG), BGBl. I Nr. 150/2021 (2021). https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20011619

Bundesgesetz über den Nationalen Qualifikationsrahmen, Pub. L. No. BGBl 14/2016 vom 21. März 2016 (2016).

Bundesgesetz über die erneuerbare Wärmebereitstellung in neuen Baulichkeiten (Erneuerbare-Wärme-Gesetz – EWG), BGBl. I Nr. 8/2024 (2024). https://www.ris.bka.gv.at/eli/bgbl/I/2024/8/20240228

Bundesgesetz über die Pflicht zur Vorlage eines Energieausweises beim Verkauf und bei der In-Bestand-Gabe von Gebäuden und Nutzungsobjekten (Energieausweis-Vorlage-Gesetz 2012 – EAVG 2012), BGBl. I Nr. 27/2012 (2012). https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20007799

Bundesgesetz über die Steigerung der Energieeffizienz bei Unternehmen und dem Bund, Fassung vom 23.02.2023, BGBl. I Nr. 72/2014 (2014). https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20008914

Bundesgesetz zur Einhaltung von Höchstmengen von Treibhausgasemissionen und zur Erarbeitung von wirksamen Maßnahmen zum Klimaschutz (Klimaschutzgesetz – KSG), BGBl. I Nr. 106/2011 (2013). https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20007500

Bundesinnung Bau. (2022). *Berufszugang Baugewerbetreibende*. WKO Bundesinnung Bau.

Dornmayr, Helmut, & Riepl, Marlis. (2022). *Unternehmensbefragung zum Fachkräftebedarf/-mangel—Fachkräfteradar 2022* (Nr. ibw–Forschungsbericht Nr. 210). ibw Institut für Bildungsforschung der Wirtschaft. https://www.wko.at/service/unternehmensfuehrung-finanzierung-foerderungen/fachkraefteradar.html

Dubois, Alexandre, Hedin, Sigrid, Schmitt, Peter, & Sterling, José. (2009). *EU Macro-regions and Macro-regional Strategies—A Scoping Study. Nordregio Electronic Working Paper 4*. http://norden.diva-portal.org/smash/get/diva2:700381/FULLTEXT01.pdf

Empfehlung des Europäischen Parlaments und des Rates zur Einrichtung des Europäischen Qualifikationsrahmens für lebenslanges Lernen, 2008/C 111/01 (23. April 2008). http://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32008H0506%2801%29&from=DE

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A Roadmap for moving to a competitive low carbon economy in 2050, KOM(2011) 112 endgültig (2011). https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=celex%3A52011DC0112

Proposal for a DIRECTIVE on energy efficiency (recast), COM/2021/558 final, (2021) (testimony of European Commission). https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:52021PC0558&from=EN

European Commission – Department: Energy. (2020, Februar 17). *In focus: Energy efficiency in buildings*. https://commission.europa.eu/news/focus-energy-efficiency-buildings-2020-02-17_en

Commission Recommendation (EU) 2020/1563 of 14 October 2020 on energy poverty, 357 OJ L (2020). http://data.europa.eu/eli/reco/2020/1563/oj/eng

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently

repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L (2009). http://data.europa.eu/eli/dir/2009/28/oj/eng

Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast), (2012). https://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=FZMjThLLzfxmmMCQGp2Y1s2d3TjwtD8QS3pqdkhXZbwqGwlgY9KN!2064651424?uri=CELEX:32010L0031

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC Text with EEA relevance, OJ L (2012). http://data.europa.eu/eli/dir/2012/27/oj/eng

Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (Text with EEA relevance.), 328 OJ L (2018). http://data.europa.eu/eli/reg/2018/1999/oj/eng

Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), (2021). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1119

Regulation (EU) 2023/857 of the European Parliament and of the Council of 19 April 2023 amending Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement, and Regulation (EU) 2018/1999 (Text with EEA relevance), 111 OJ L (2023). http://data.europa.eu/eli/reg/2023/857/oj/eng

Fechner, Hubert. (2020). *Ermittlung des Flächenpotentials für den Photovoltaik-Ausbau in Österreich: Welche Flächenkategorien sind für die Erschließung von besonderer Bedeutung, um das Ökostromziel realisieren zu können mit Fokus auf bis 2030 realisierbare PV-Potentiale im Gebäudesektor und technische Potentiale auf anderen Flächen* [Endbericht]. Studie im Auftrag von Österreichs Energie. https://oesterreichsenergie.at/downloads/dossiers-1/photovoltaik-ausbau-in-oesterreich

Fechner, Johannes, & Selinger, Johannes. (2013). *Roadmap Aus- und Weiterbildung von Fachkräften in der Bauwirtschaft, BUILD UP Skills Austria*. 17&4 Organisationsberatung.

Foray, Dominique, Mowery, David C., & Nelson, Richard R. (2012). Public R&D and social challenges: What lessons from mission R&D programs? *Research Policy*, *41*(10), 1697–1702. https://doi.org/10.1016/j.respol.2012.07.011

Gänzle, Stefan, Stead, Dominic, Sielker, Franziska, & Chilla, Tobias. (2018). Macro-regional Strategies, Cohesion Policy and Regional Cooperation in the European Union: Towards a Research Agenda. *Political Studies Review*. https://doi.org/10.1177/1478929918781982

Geissler, Susanne. (2022). *Analysis of the directly and indirectly relevant EU framework with the perspective 2030 and beyond, working document*.

Geissler, Susanne. (2023). *Definition of future scenarios, working document*.

Gornik, Elke. (2019). Wissenschaftliche Weiterbildung in Österreich. In Wolfgang Jütte & Matthias Rohs (Hrsg.), *Handbuch Wissenschaftliche Weiterbildung* (p. 1–20). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-17674-7_32-2

Grêt-Regamey, Adrienne, & Brunner, Sibyl. (2011). Methodischer Rahmen für den Einsatz von Backcasting zur Anpassung an den Klimawandel. *disP*, *184*, 43–51. https://doi.org/10.1080/02513625.2011.10557123

Grohs, Julia, Kirchengast, Gottfried, Kromp-Kolb, Helga, Steininger, Karl, Stagl, Sigrid, Kirchner, Mathias, Ambach, Christoph, Strunk, Birte, Gutsohn, Andrea, & Peisker, Jonas. (2019). *Referenzplan als Grundlage für einen wissenschaftlich fundierten und mit den Pariser Klimazielen in Einklang stehenden Nationalen Energie- und Klimaplan für Österreich (Ref-NEKP) Gesamtplan* (Verlag der ÖAW, Hrsg.). https://epub.oeaw.ac.at/8497-3

Gruber, Elke, & Lenz, Werner. (2016). *Erwachsenen- und Weiterbildung Österreich* (3. Aufl.). W. Bertelsmann.

Grubinger, Stefan. (2023, März). *Interview mit recordIT Geschäftsführer Stefan Grubinger* [Persönliche Kommunikation].

Handwerk + Bau. (2022). *Ausgebildete Fachkräfte immer dringender gesucht*. https://www.handwerkundbau.at/wirtschaft/fachkraeftemangel-fachkraefte-immer-dringender-gesucht-49347

Hasebrook, Joachim, & Zinn, Bernd. (2018). *Lebensphasen und Kompetenzmanagement. Ein Berufsleben lang Kompetenzen erhalten und entwickeln* (Alexander Schletz, Hrsg.; 1. Aufl.). Springer Berlin Heidelberg.

Hefler, Günter, Luomi-Messerer, Karin, Steinheimer, Eva, & Wulz, Janine. (2018). *Wissenschaftliche Begleitung und Monitoring der Österreichischen Strategie zum lebensbegleitenden Lernen. Monitoringbericht für die Jahre 2016 und 2017*. 3s Gmbh.

Henneberger, Clara, & Steiner, Tobias. (2022). *Entwicklungen in der Thermischen Sanierung: Politische, gesellschaftliche und gesetzliche Rahmenbedingungen in Österreich*. https://www.ibo.at/wissensverbreitung/ibomagazin-online/ibo-magazin-artikel/data/entwicklungen-in-der-thermischen-sanierung

Hubner, Wolfgang. (2021). Instandhaltung: Checkliste für die Flachdach-Wartung. *Handwerk+Bau*. https://www.handwerkundbau.at/dach/checkliste-fuer-die-flachdach-wartung-41690

ibw. (2021). *Die Lehre. Duale Berufsausbildung in Österreich*. ibw.

Käpplinger, Bernd. (2016). *Betriebliche Weiterbildung aus der Perspektive von Konfigurationstheorien*. W. Bertelsmann.

Kulhanek, Andrea, Binder, David, Unger, Martin, & Schwarz, Anna. (2019). *Stand und Entwicklung wissenschaftlicher Weiterbildung in Österreich* (Studie im Auftrag des Bundesministeriums für Bildung, Wissenschaft und Forschung Endbericht). Institut für Höhere

Studien – Institute for Advanced Studies (IHS). https://irihs.ihs.ac.at/id/eprint/5266/1/2019-ihs-report-kulhanek-binder-unger-stand-wissenschaftlicher-weiterbildung-oesterreich.pdf

Lechinger, Vanessa, & Matzinger, Sandra. (2020). So heizt Österreich: Heizungsarten und Energieträger in österreichischen Haushalten im sozialen Kontext, Kurzstudie im Auftrag der Arbeiterkammer. *Wirtschaftspolitik Standpunkte*, *36*. https://wien.arbeiterkammer.at/service/newsletter/wirtschaftspolitik/WP-Standpunkte_2020_01.pdf

Lenz, Werner. (2005a). *Portrait Weiterbildung Österreich* (2.). Bertelsmann.

Lenz, Werner. (2005b). *Portrait Weiterbildung Österreich* (2.). Bertelsmann.

Lindinger, Andreas, Wauro, Darina, & Vollgruber, Doris. (2023). *Just Transition Aktionsplan Aus- und Weiterbildung* (BMK, Hrsg.). https://www.bmk.gv.at/themen/klima_umwelt/nachhaltigkeit/green_jobs/just-transition.html

Markowitsch, Jörg, & Hefler, Günter. (2018). Staying in the Loop: Formal Feedback Mechanisms Connecting Vocational Training to the World of Work in Europe. *International Journal for Research in Vocational Education and Training*, Vol 5 No 4 (2018)-. https://doi.org/10.13152/ijrvet.5.4.3

Mayerl, Martin, Lachmayr, Norbert, & Bauer, Verena. (2021). *Die Ausbildungssituation von Studierenden an Schulen für Berufstätige in Wien* [Projektabschlussbericht]. öibf.

Mikulits, Thoma, Stadler. (2020). *OIB-Dokument zur Langfristigen Renovierungsstrategie gemäß Richtlinie 2010/31/EU des Europäischen Parlaments und des Rates vom 19. Mai 2010 über die Gesamtenergieeffizienz von Gebäuden in der konsolidierten Fassung vom 30. Mai 2018*.

Monsberger, Michael, & Fruhwirth, Michael. (2018). *Die Gebäudetechnik im österreichischen Bauprozess. Eine Studie über Herausforderungen in komplexen Hochbauprojekten aus Sicht unterschiedlicher Stakeholder am Bau* (Nr. 2; Forschungsreihe iBBW, p. 1–127). IBBW.

NEVARIS. (2022, Dezember 6). Baubranche 2023: Zukunft-Prognose zur Baukonjunktur | NEVARIS [Unternehmens-Website]. *NEVARIS Blog*. https://www.nevaris.com/blog/wie-geht-es-der-baubranche/

North, Klaus, Reinhardt, Kai, & Sieber-Suter, Barbara. (2013). *Kompetenzmanagement in der Praxis. Mitarbeiterkompetenzen systematisch identifizieren, nutzen und entwickeln; mit vielen Fallbeispielen* (2. Aufl.). Springer Gabler.

ÖROK. (2022). *ÖROK-Regionalprognosen 2021 bis 2050: Bevölkerung* (Geschäftsstelle der Österreichischen Raumordnungskonferenz, Hrsg.). https://www.oerok.gv.at/fileadmin/user_upload/publikationen/Schriftenreihe/212/O__ROK_212_OEROK-BevPrognose_2021-2050.pdf

Österreichisches Institut für Bautechnik - OIB. (2019). *OIB Richtlinie 6 Energieeinsparung und Wärmeschutz OIB-330.6-026/19* (Österreichisches Institut für Bautechnik - OIB, Hrsg.). https://www.oib.or.at/de/oib-richtlinien/richtlinien/2019/oib-richtlinie-6

Photovoltaic Austria. (2022). *Die österreichische Photovoltaik- und Speicherbranche in Zahlen*. https://pvaustria.at/wp-content/uploads/2022_Fact_Sheet_PV_Branche.pdf

PlanRadar. (2023, Februar 10). 15 häufige Baumängel: Fragen und Antworten [Unternehmens-Website]. *Die Zukunft bauen - Digitalisierung von Bau, Immobilien und Facility Management*. https://www.planradar.com/at/15-haeufigste-baumaengel/

Qualität in der Lehre. (2022, Februar 22). *Ausbildungsleitfäden—Handbücher für die betriebliche Ausbildung*. Qualität in der Lehre. https://www.qualitaet-lehre.at/downloads/ausbildungstools/ausbildungsleitfaeden/

Regierungsvorlage: Bundesgesetz zum Ausstieg aus der fossil betriebenen Wärmebereitstellung (Erneuerbare-Wärme–Gesetz—EWG), (2022). https://www.parlament.gv.at/gegenstand/XXVII/ME/212

Schlögl, Peter, & Mayerl, Martin. (2016). *Betriebsbefragung zu Kosten und Nutzen der Lehrausbildung in Österreich. Teilbericht im Rahmen der ibw-öibf-Studie „Hintergrundanalyse zur Wirksamkeit der betrieblichen Lehrstellenförderung (gemäß 19c BAG)"*. öibf.

Schrader, Josef. (2010). Reprodukationskontexte der Weiterbildung. *Zeitschrift für Pädagogik*, *56*(2), 267–284. https://doi.org/10.25656/01:7146

Siebert, Horst. (2003). *Didaktisches Handeln in der Erwachsenenbildung. Didaktik aus konstruktivistischer Sicht* (4. Aufl.). Luchterhand.

Statista. (2023). *Österreich—Lebenslanges Lernen 2022*. Statista. https://de.statista.com/statistik/daten/studie/883414/umfrage/wichtigkeit-und-umsetzung-von-lebenslangem-lernen-in-oesterreich/

Statistik Austria. (2011). *Mikrozensus: Anzahl der Wohnungen im Gebäude, Anzahl der Hauptwohnsitze im Gebäude, Nettogrundfläche in Quadratmetern, Gebäude*. Statistik Austria.

Statistik Austria. (2018). *Erwachsenenbildung. Ergebnisse des Adult Education Survey (AES)*. Statistik Austria.

Statistik Austria. (2022a). *GWR - Gebäude- und Wohnungsregister, Handbuch A, Kapitel 1, Überblick über das Adress-, Gebäude- und Wohnungsregister*. https://www.statistik.at/fileadmin/pages/489/HandbuchA1Ueberblick2022.pdf

Statistik Austria. (2023a). *Betriebliche Weiterbildung 2020* ((CVTS6)). https://www.statistik.at/services/tools/services/publikationen/detail/1486

Statistik Austria. (2023b). *Statistik Austria, Hochschulstatistik*.

Statistik Austria. (2022b). *2021 höchste Wohnbautätigkeit seit Beginn der 1980er-Jahre: Pressemitteilung: 12 938-236/22*. https://www.statistik.at/fileadmin/announcement/2022/11/20221115WohnbautaetigkeitWohnungsbestandsfortschreibung2021.pdf

Statistik Austria. (2023c). *Weiterbildungsaktivitäten der Bevölkerung*. STATISTIK AUSTRIA. https://www.statistik.at/statistiken/bevoelkerung-und-soziales/bildung/weiterbildungsaktivitaeten-der-bevoelkerung

Stead, Dominic, Geerlings, Harry, & Shiftan, Yoram. (2016). Epilogue: The role of instruments, individuals and institutions in promoting sustainable transport: Concluding remarks. In

Transition towards sustainable mobility: The role of instruments, individuals and institutions (p. 347–356).

Struber, Christian. (2019). *Gemeindegebäude effizient sanieren*. https://kommunal.at/gemeindegebaeude-effizient-sanieren

Thenius, Gregor, Knaus, Karina, & Sahin, Selina. (2023). *Green Jobs 2030+ Einordnung des Arbeitskräftebedarfs für die Erreichung zentraler Ziele der Energiewende* [Beauftragt vom Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie]. Österreichische Energieagentur. https://www.bmk.gv.at/dam/jcr:3f79e5a2-c1a8-4231-8879-c918fa8ec36a/GreenJobs_2030.pdf

Tretter, Herbert, Melmuka, Angelika, Knaus, Karina, Altmann-Mavaddat, Naghmeh, & Sahin, Altan. (2022). *Kompetenzen für die klimaneutrale Zukunft; Ergebnisse zur Projekterweiterung „Bildungsdialog Klima"* [Endbericht]. Auftraggeber: Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (BMK). https://erasmusplus.at/fileadmin/Dokumente/erasmusplus.at/Aktuelles/2022/BB/Bildungsdialog_Endbericht_final_barrierfrei_2022-05-03.pdf

Umweltbundesamt. (2021). *Öl- und Gasheizungen—Bestand und Tauschkurve. Beitrag zum „Koordinationsteamtreffen Wärmestrategie"*. Umweltbundesamt.

Umweltbundesamt. (2023). *Flächeninanspruchnahme*. www.umwelbundesamt.at. https://www.umweltbundesamt.at/umweltthemen/boden/flaecheninanspruchnahme

Verordnung Installations- und Gebäudetechnik—Ausbildungsordnung, 63 (2008).

Wach, Iris. (2022). *Die Arbeitsmarktlage in der Bauwirtschaft*. AMS Österreich.

Wechselberger, Lena. (2023, Januar 18). *TGA - Fachkräftemangel in Österreich: Daten und Lösungen* [Online-Magazin]. TGA. https://tga.at/branche/fachkraft-gesucht-und-jetzt/

x-sample. (2018). *Befragung von Absolventinnen und Absolventen der TU Graz* [Studie im Auftrag der TU Graz].

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14 Appendix

14.1 Appendix I: Relevant professional profiles

Table 1: Relevant occupational profiles with typical qualification level for the thematic delimitation of the analyses in the area of education and training

	Relevance of the professional group in relation to the objective*	< NQF4	NQF4	NQF4	NQF5	NQF5	NQF6, NQF7	NQF6, NQF7, NQF8	Without assignment
		Apprentice and unskilled occupations	Apprenticeship training	Intermediate vocational school (BMS)	College for higher vocational education (BHS)	Post-secondary VET courses (Kollegs)	University of applied sciences study programs	University studies	Special training and continuing education courses
Architect	3						x	x	
Site manager	3		x	x	x	x	x	x	
Building fitter	3	x	x						
Construction foreman	3		x	x					x
Construction technician	3			x	x	x	x	x	
Facade technician	3	x	x	x					
Prefabricated house builder	3		x	x					
Building services engineer	3				x	x	x	x	
Carpenter	3		x	x					
Electrical technician for installation and building services engineering	3		x	x					
Installation and building technician	3		x	x					
Solar technician	3		x	x	x	x	x	x	x
Sun protection technician	3		x						

	Relevance of the professional group in relation to the objective*	< NQF4	NQF4	NQF4	NQF5	NQF5	NQF6, NQF7	NQF6, NQF7, NQF8	Without assignment
		Apprentice and unskilled occupations	Apprenticeship training	Intermediate vocational school (BMS)	College for higher vocational education (BHS)	Post-secondary VET courses (Kollegs)	University of applied sciences study programs	University studies	Special training and continuing education courses
Plasterer and drywaller	3		x	x					
Heat, cold, sound, and fire protection technician	3	x	x						
Carpenter	3		x	x					
Real estate manager	3		x		x	x	x	x	x
Energy consultant	3		x	x	x	x	x	x	x
Wind energy technician	3		x	x	x	x			x
Sewage and waste management technician	3				x	x	x	x	
Waste disposal and recycling technician	3	x	x	x	x	x	x	x	
Civil engineering assistant	2		x			x			
Civil draftsman	2		x						
Concrete worker (formerly formwork worker)	2		x	x					x
Precast concrete technician	2		x	x					
Roofer	2		x						
Stove fitter	2		x	x	x	x			
Bricklayer (older designation for structural engineer)	2		x	x					

	Relevance of the professional group in relation to the objective*	< NQF4	NQF4	NQF4	NQF5	NQF5	NQF6, NQF7	NQF6, NQF7, NQF8	Without assignment
		Apprentice and unskilled occupations	Apprenticeship training	Intermediate vocational school (BMS)	College for higher vocational education (BHS)	Post-secondary VET courses (Kollegs)	University of applied sciences study programs	University studies	Special training and continuing education courses
Industrial engineer	2				x	x	x	x	
Service technician	2		x	x	x	x			
Landscape planners (missing in AMS systematics)	2							x	
Wood technician	2		x	x	x	x	x	x	
Carpenter	2		x	x	x	x			
Project manager	2				x	x	x	x	
Environmental manager	2				x	x	x	x	
Environmental consultant	2		x	x	x	x	x	x	x
Plant technician	2		x	x	x	x	x	x	
Automation technician	2		x	x	x		x	x	
Electrical engineer for plant and operating technology	2		x	x	x	x			
Refrigeration technician	2		x	x	x	x			
Mechanical engineer	2				x	x	x	x	
Mechanical engineering technician	2		x	x	x	x			
Machine setter	2		x	x					
Electrical power technician	2		x	x	x	x	x	x	

	Relevance of the professional group in relation to the objective*	< NQF4	NQF4	NQF4	NQF5	NQF5	NQF6, NQF7	NQF6, NQF7, NQF8	Without assignment
		Apprentice and unskilled occupations	Apprenticeship training	Intermediate vocational school (BMS)	College for higher vocational education (BHS)	Post-secondary VET courses (Kollegs)	University of applied sciences study programs	University studies	Special training and continuing education courses
Electrical engineer	2				x	x	x	x	
Environmental technician	2			x	x	x	x	x	
General unskilled worker	1	x							
Construction helper in building construction	1	x							
Construction helper in civil engineering	1	x							
Woodworking assistant	1	x							
Auxiliary worker in the building industry	1	x							
Auxiliary in the Heating, Ventilation and Air Conditioning installation area	1	x							
Building plumber	1		x	x					
Civil engineer	1		x	x					
Electrical assistant	1	x							
Auxiliary in the GWHS installation area	1	x							
Floor layer	1		x						
Furnishing consultant	1		x	x	x	x			

	Relevance of the professional group in relation to the objective*	< NQF4	NQF4	NQF4	NQF5	NQF5	NQF6, NQF7	NQF6, NQF7, NQF8	Without assignment
		Apprentice and unskilled occupations	Apprenticeship training	Intermediate vocational school (BMS)	College for higher vocational education (BHS)	Post-secondary VET courses (Kollegs)	University of applied sciences study programs	University studies	Special training and continuing education courses
Painter and coating technician	1		x	x					
Slab and tile layer	1		x	x					
Upholsterer and decorator	1		x						
Horticultural technician	1			x	x	x	x	x	
Cultural technician	1				x	x	x	x	
Woodworking assistant	1	x							
Business economist	1						x	x	
Financial and investment advisor	1		x	x	x	x	x	x	
Finance manager	1						x	x	
Risk manager in finance and banking	1				x	x	x	x	
Bid manager	1				x	x	x	x	
Caretaker	1	x							
Housekeeper	1	x							x

Source: Own representation; occupational profiles and typical qualification level according to the AMS occupational information system (https://bis.ams.or.at/bis/berufe-nach-berufsbereichen, retrieved on 21.12.2022)

* 3 = high, 2 = medium, 1 = low relevance for achieving energy and climate targets in the building sector

14.2 Appendix II: Providers and offers in the area of continuing vocational training

Table 23: Providers and offers of continuing vocational training with reference to relevant competences for the achievement of climate targets in the building sector

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
Acht-Engineering	https://www.acht.at/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen	BIM-Ausbildungen	1f	3
ALLPLAN Österreich GmbH	https://www.allplan.com/at/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen; Teil der Nemetschek Group	BIM-Ausbildungen, „Bauen im Bestand“, „Energiesimulation“ et cetera	1a, 1f	3
A-Null	https://www.a-null.com/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen	Bauphysik, BIM-Ausbildungen	1a, 1f	3
Arbeitsgemeinschaft Energieberater/innen-Ausbildung (ARGE EBA) – Mitglieder (Infos siehe unten): • Burgenländischer Ökoenergiefonds • Land Kärnten • Energie- und Umweltagentur NÖ (enu) • Oberösterreichischer Energiesparverband • Energie Agentur Steiermark • Energie Tirol • Energieinstitut Vorarlberg • Stadt Wien – Umweltberatung	https://arge-eba.net/ Organisation aller österreichischen Bundesländer beziehungsweise ihrer Landesenergieagenturen für die Ausbildung zu Energieberater:innen	Ausbildung zu Energieberater:innen, dnergieeffizientes Bauen und Sanieren, Gebäude-Bewertungssysteme, Sanierung in Schutzzonen	1a, 1d, 2b, 2d, 2h, 3e	1

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
Energieberatung Salzburg				
ARS Akademie	https://ars.at/ privater Fachseminaranbieter, mit 13 Schwerpunktthemen unter anderem Bau- und Immobilienwirtschaft	• BIM-Ausbildungen • Energie(recht), Nachhaltigkeit & Wirtschaftlichkeit • Energieeffizienzprojekte: Energie-Contracting und erneuerbare Energieträger • Energiegemeinschaften • Umsetzung von Energievorgaben • Bauschäden und Baumängel	1a, 1f, 2b, 3e	3
ARTAKER CAD Systems	https://www.artaker.com/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen	• BIM-Ausbildungen • CAD-Schulungen • BIM-und-buildingSmart-Ausbildung	1f, 1g	3
ATS Architektur Technologie Service	https://www.team-ats.at/de Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen	• BIM-Ausbildungen • ArchiCAD Kurse • ArchiPHYSIK Kurse • S/W-Schulungen	1a, 1f	3
Austrian Institute of Technology (AIT)	https://www.ait.ac.at/ beziehungsweise https://www.ait.ac.at/themen/training-education	Weiterbildungsprogramme zu Wärmepumpen, Solarthermie, Photovoltaik, Komfortlüftung, Digitale Planung, Data Science klima**aktiv** Bildungspartner (Photovoltaik, Wärmepumpe)	1a, 1c, 1d, 3e	1
Austrian Standards	https://www.austrian-standards.at/de/produkte-loesungen/seminare-lehrgaenge Weiterbildung bei Austrian Standards in Form von Fachkongressen, Inhouse-Schulungen, Seminaren und Lehrgängen	• BIM-Ausbildungen • Fachgerechte Fenstermontage	1f, 1a	?
ATGA	http://www.atga.com/ Institut für Facility Management	zum Beispiel Gebäudeautomation und MSR-Technik, Energieeffizienz in der	1a, 1d, 1g	3

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
	Aus- und Weiterbildungen in der technischen Gebäudeausrüstung	Gebäudetechnik, HLK-Technik, Gebäudeautomation und MSR-Technik		
BAUAkademien Österreich	https://www.bauakademie.at/ Spezialist für Aus- und Weiterbildungen für Lehrlinge sowie Fach- und Führungskräfte am Bau; acht Standorte in Österreich	zum Beispiel im Bereich Bautechnik/Energieeffizienz 128 Kurse (laut Kursdatenbankabfrage am 11.1.2023) MSc Lehrgang für BIM – Buildung Information Modeling; Zertifizierung buildingSMART; Ökologie und Baubiologie in der Praxis klima**aktiv** Bildungspartner Gebäudestandard	1a, 1f, 1g, 3e	2
Österreichische Bautechnikvereinigung	https://www.betonakademie.at/ https://www.digitalakademie.at/	Betonakademie, Digitalakademie; Gebäudeinstandsetzung, BIM in Theorie und Praxis	1f, 2b	2
Berufsförderungsinstitut Österreich (bfi)	www.bfi.at Aus- und Weiterbildungseinrichtung der Kammern für Arbeiter und Angestellte und des Österreichischen Gewerkschaftsbundes	Kurse im Bereich Technik, Ökologie, Sicherheit; zum Beispiel Vorarbeiter:n im Hochbau – Bauwerksabdichtung und Baustoffkunde, Installations- und Gebäudetechnik, AutoCAD, Kälteanlagentechnik Schulungen zu den Themen Energieausweis, Energieeffizienz von Gebäuden und Energiemanagement; Technik, Ökologie und Sicherheit; Solarthermie, Photovoltaik siehe zum Beispiel: erste Solarteur-Schule Kärntens 2013 gestartet https://www.bfi-kaernten.at/aut_de_html-6-aktuelles.php?pageId=erste-solarteur-schule-kaerntens-gestartet-14 aktuell: erstes Klimaschutz-Ausbildungszentrum in NÖ von AMS und BFI	1a, 3e	2

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
		NÖ https://www.ams.at/regionen/niederoesterreich/news/2022/06/ams-und-bfi-noe-errichten-1--klimaschutz-ausbildungszentrum-in-e		
Bi.f – Bauingenieur.Fortbildung an der Fakultät für Bauingenieurwesen der TU Wien	https://bauwesen.tuwien.ac.at/studium/fortbildung/bif/	BIMcert Ausbildung (in Kooperation mit Überbau, siehe unten), BIM-Zertifizierung nach buildingSMART-Austria-Standard	1f	1
b.i.m.m	https://bimm.eu/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen; eigene bimm-Tools	BIM-Ausbildungen (BIM-Manager, BIM-Services, BIM-Software)	1f	3
Build Desk Ecotech	https://www.builddesk.at/	Energieausweisrelevante Schulungen	1a	3
Business Circle	https://businesscircle.at privater Anbieter von Fachseminaren und Tagungen	• Konferenz: BIM Forum – Building Information Modeling, Digitalisierung der Bau- und Immobilienwirtschaft • Fachtagung ESG in der Immobilienwirtschaft	1f	3
Digital findet Stadt	https://www.digitalfindetstadt.at/akademie FFG Innovationslabor, Schulungsangebote und Events, Onlinematerial	• BIM-Qualifizierungen • Workshops zu kreislauffähigem Sanieren	1f, 3e	2 (Innovationslabor)
Ecotech Akademie	http://www.ecotechakademie.at/ privater Anbieter	Seminare zu Energieausweisberechnung und Baubiologie	1f, 3e	
Energie Agentur Steiermark **Energieberater:innen-Ausbildung (ARGE EBA)**	www.ea-stmk.at Organisation des Landes Steiermark zur Förderung von Energieeffizienz und Nutzung erneuerbarer Energieträger	Ausbildung zu Energieberater:innen (ARGE EBA) sowie vielfältige Aus- und Weiterbildungen für unterschiedliche Zielgruppen, von	1a, 1d, 2b, 2d, 2h, 3e	1

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
		Neueinsteiger:innen bis Expert:innen; Bauen und Sanieren		
Energie- und Umweltagentur Niederösterreich (eNu)	www.enu.at Einrichtung des Landes NÖ; neu Bildung & Wissen ist ö-cert-Anbieter https://www.enu.at/weiterbildung	Ausbildung zu Energieberater:innen (ARGE EBA) sowie vielfältige niederschwellige Aus- und Weiterbildungen	1a, 1d, 2b, 2d, 2h, 3e	1
Energie Tirol – Energie Akademie	https://www.energie-tirol.at/energie-akademie/die-tiroler-energie-akademie/ Einrichtung von Energie Tirol und Land Tirol	Ausbildung zu Energieberater:innen (ARGE EBA) sowie vielfältige Weiterbildungsangebote für unterschiedliche Zielgruppen zu Bau- und Haustechnik, erneuerbare Energien und Energieeffizienz	1a, 1d, 2b, 2d, 2h, 3e	1
Energieinstitut Vorarlberg	www.energieinstitut.at	Ausbildung zu Energieberater:innen (ARGE EBA) Lehrgang Gebäude & Energie Basislehrgang (A-Kurs) sowie niederschwellige Informations- und Bildungsangebote zum energieeffizienten und ökologischen Bauen und Sanieren, Heizen und Haustechnik	1a, 1d, 2b, 2d, 2h, 3e	1
greenskills	https://www.greenskills.at/ Bildungsangebot des Vereins United Creations	Haustechnik & Energieversorgung; ökologische Materialien Lehrgang für nachhaltiges Bauen (in Kooperation mit BAUAkademie Wien)	1a, 1d, 3e	3

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
GrünStattGrau GmbH	https://gruenstattgrau.at/ Forschungs- und Innovations-GmbH zum Thema Bauwerksbegrünung	Modularisierte Weiterbildungsangebote zu Bauwerksbegrünung; EU-Gebäuderichtlinien, Kreislaufwirtschaft	1a, 3e	2 (Innovationslabor)
HABRA	https://www.habra.at/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen in OÖ und S	BIM-Ausbildungen ArchiCAD-Kurse	1f	3
Hauskunft	https://www.hauskunft-wien.at/ Servicestelle des Wohnfonds Wien der Stadt Wien	Zum Beispiel Webinar „Umsetzung und Förderung der Dekarbonisierung im mehrgeschoßigen Wohnungsbestand“; „Hauskunft-Expert*innentag“ sowie Veranstaltungen in Kooperation mit ÖVI, Qualitätsplattform Sanierungspartner, Renowave.at und klima**aktiv** Erneuerbare Wärme	2b	1
IBO Österreichisches Institut für Baubiologie und -ökologie	https://www.ibo.at/ wissenschaftlicher Verein zu ökologischer Architektur – Forschung und Wissensverbreitung zu Materialökologie, Gebäudebewertung, Bauphysik, Messungen	klima**aktiv** Bildungspartner Werkstattgespräche zu Neuigkeiten über baubiologische und -ökologische Themen von Expert:innen Prüfinstitut für das Zertifikat „Qualitätsgeprüftes Passivhaus“ weiters Wissensverbreitung über Beratungen, BAUZ!-Publikationen	1a, 1c, 1d, 2b, 3e	2
IFB Institut für Flachdachbau und Bauwerksabdichtung	https://ifb.co.at/ Verein für Fortbildung, Innovation, Qualitätssicherung und Öffentlichkeitsarbeit zur Errichtung und Erhaltung von Gebäudehüllen verfügt über CERTNÖ	Bildungsangebote für Planer:innen, Bauherr:innen und Interessierte zu Gebäudehüllen, Bauwerksabdichtung und Ähnlichem Zum Beispiel „Ausbildung Bauwerksabdichter:in“ oder Seminare	1a, 1c, 2b	3

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
		Gebäudehülle, Feuchte- und Dichtheitsmonitoring (= Universitätskurse in Kooperation mit TU Wien und TU Graz)		
imh Institut Manfred Hämmerle GmbH	https://www.imh.at Privater Konferenz- und Seminaranbieter, unter anderem zu Themenbereichen Immobilen – Bau, Energie – Verkehr und Nachhaltigkeit	• ESG in der Immobilienwirtschaft • Fachkonferenz „Nachhaltigkeit im Bildungsbau“; „Rolle von CO_2 und Bepreisung bei Immobilienprojekten“	1a, 3e	3
iBBW Institut für Baubetrieb und Bauwirtschaft der TU Graz	https://www.tugraz.at/institute/bbw/home/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen	BIM-Schulungen	1f	1
Klimaschutz-Ausbildungszentrum in NÖ von AMS und Bfi NÖ	https://www.ams.at/regionen/niederoesterreich/news/2022/06/ams-und-bfi-noe-errichten-1--klimaschutz-ausbildungszentrum-in-e	Gebäudetechnik und Smarthome; Ökologie und Sicherheit; Solarthermie, Photovoltaik	1a, 1g, 3e	
Mensch und Maschine Austria GmbH	https://www.mum.at/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen Anbieter von Computer Aided Design Manufacturing/Building (CAD/CAM/BIM)	BIM-Ausbildungen; CAD, CAM	1f	3
Oberösterreichischer Energiesparverband – Energie Academy	https://www.energiesparverband.at/veranstaltungen/energy-academy Einrichtung des Landes Oberösterreich zur Förderung von Energieeffizienz, erneuerbarer Energie, E-Mobilität und Energietechnologien	Ausbildung für Energieberater:innen (ARGE EBA) Training und Weiterbildung zu erneuerbarer Energie, Energieeffizienz, Energiekostenreduktion, Energietechnik, Bautechnik, Energieberatung	1a, 1d, 2b, 2d, 2h, 3e	1
ÖGNB Österreichische Gesellschaft für Nachhaltiges Bauen	https://www.oegnb.net/ gemeinnütziger Verein zur Förderung von nachhaltigem Bauen	Lehrgang „ÖGNB-Gütesiegel für Wohngebäude“ in Kooperation mit dem Energieinstitut Vorarlberg, der	1a, 1c, 3e	2

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
		Donauuniversität Krems und dem IBO https://www.oegnb.net/ausbildung.htm		
ÖVI Immobilienakademie Betriebs-GmbH	https://www.immobilienakademie.at/	zum Beispiel Lehrgang „Nachhaltige Gebäudesanierung und Heizungstausch“	1a, 2b, 2c	2
Photovoltaik Austria Verband	https://pvaustria.at/ Bundesverband zur Interessenvertretung zur Verbesserung der Rahmenbedingungen für PV und Stromspeicherung in Österreich; Praxis- und Ausbildungszentrum https://pvaustria.at/ausbildung/	Weiterbildungen – gemeinsam mit TÜV Austria Akademie, zum Beispiel: Lehrgang Zertifizierte:r Photovoltaik-Praktiker:in (https://pvaustria.at/pv-spezialist/; Seminar Fit für PV, PV-Normenlandschaft, Mechanische PV-Montage	3e	2
Renowave.at	https://www.renowave.at/ Innovationslabor zum Thema klimaneutrale Sanierungen (Genossenschaft)	Innovationswerkstätten, Lehrgänge, et cetera zum Beispiel Praxis-Lehrgang: Raus aus Öl und Gas; Krise – Innovation – Kreislaufwirtschaft	2b, 2d, 3e	2 (Innovationslabor)
QWS Qualitätsgruppe Wärmedämmsysteme	https://www.waermedaemmsysteme.at/ und http://zfv.waermedaemmsysteme.at/ Zusammenschluss der größten Anbieter von Wärmedämmverbundsystemen (WDVS) in Ö	Zertifizierung als Zertifizierte:r WDVS-Fachverarbeiter:in (ZFV) in Kooperation mit BAUAkademien und Wien-Zert (Zertifizierungsstelle für Bauprodukte) (40 h Ausbildung, bei BAUAkademien)	1c	2
Roiger	www.roiger.at Aus- und Weiterbildungen von Hans Roiger für Investor:innen, Bauherr:innen, Immobilienmanager:innen, Bauleiter:innen, Betreiber:innen, und Techniker:innen	Energiesparen kompakt; HLK, Mess-, Steuer- und Regelungstechnik	1a, 1d, 1g	3
Schulungszentrum Fohnsdorf	www.sfz.at	zum Beispiel Qualifizierungen CAD Bautechnik und Bauökologie; Elektropraktiker:in Photovoltaik	1a, 1f, 3e	1

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
	Bildungseinrichtung /gemeinnütziger Verein des AMS Steiermark, Stadtgemeinde Judenburg und Gemeinde Fohnsdorf			
SIDE Academy	https://www.academy.side.at/ Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen	BIM-Ausbildungen	1f	3
Sonnenplatz Großschönau	http://www.sonnenplatz.at/page.asp/-/2.htm Einrichtung der Gemeinde Großschönau mit Forschungs- und Projektarbeit zu den Themen energieeffizientes Bauen, Wohnen und Leben (erstes Passivhausdorf zum Probewohnen)	Energieberater A-Kurs in Kooperation mit eNu NÖ und klima**aktiv** Weiterbildungen für Privatpersonen, Firmen und Gemeinden	1a, 1d, 2b, 2d, 2h, 3e	1
Überbau	https://www.ueberbau.at/ beziehungsweise https://wissen.ueberbau.at/akademie/details.jsp?v=998&bim=1 Ausbildungspartner von buildingSMART Austria (bSAT) für BIM-Ausbildungen	BIMcert-Ausbildungen (in Kooperation mit bi.f TU Wien, siehe oben) Seminare in den Bereichen Technik, Bauwirtschaft, -organisation, BIM sowie Planungs- und Baurecht	1f	3
VIBÖ – Vereinigung industrieller Bauunternehmungen Österreichs	https://www.viboe.at/veranstaltungen/seminare-mit-viboe-bonus	Informationen über rechtliche Grundlagen, Pflichten und Werkzeuge der neuen grünen Beschaffung	3e	2
Wirtschaftsförderungsinstitut Österreich (WIFI)	www.wifi.at Aus- und Weiterbildungseinrichtung der Wirtschaftskammer Österreich	Weiterbildungen und Personenzertifizierungen unter anderem zu Energie-, Gebäudetechnik, Bau-/Baunebengewerbe; zum Beispiel Ausbildungen: Zertifizierte:r Photovoltaik-Techniker:in beziehungsweise -Planer:in,	1a, 1d, 1f, 1g, 2b, 3e	2

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
		Zertifizierte:r Solarwärmeinstallateur:in beziehungsweise --planer:in; Zertifizierte:r Wärmepumpentechniker:in beziehungsweise -installateur:in, Integrales Gebäude- und Energiemanagement, CAD, OIB-Richtlinien, BIM-Koordinator:in beziehungsweise -Practitioner, Ökologische Bautechnik, Energieberatung, Energieausweis; Gebäudeautomatisierung, Smarthome-Systeme, Qualifizierte Beurteilung von Gebäudesanierung, Facility Management; Produktedesign – Kreislaufwirtschaft klima**aktiv** Bildungspartner zu nachhaltigem Bauen, Heizen mit Erneuerbaren		
TÜV Austria Akademie	www.tuv-akademie.at Bildungsinstitut der TÜV AUSTRIA Gruppe	Weiterbildungen und Zertifizierungen im Bereich Sicherheit, Technik, Umwelt, Qualität und Führung; zum Beispiel zu Bau-, Gebäudetechnik, Kälte-Klima-Lüftungstechnik, Photovoltaik, Energieeffizienz & Klimaschutz	1a, 1d, 3e, eventuell weitere?	2
TÜV Süd Akademie	https://www.tuvsud.com/de-at/store/akademie-at Akademie der TÜV Süd Landesgesellschaft Österreich GmbH	Seminare und Ausbildungen, unter anderem zu Elektro- und Gebäudetechnik, Umwelttechnik – unklar, ob zu Energie/Ressourceneffizienz? BIM, Grundlagen nach buildingSMART	1f, 1g, 1e	2
Umweltberatung	https://www.umweltberatung.at/ beziehungsweise https://www.umweltberatung.at/betriebe-weiterbildung	Ausbildung zu Energieberater:innen (ARGE EBA) Bildungsangebote für den betrieblichen Umweltschutz Workshopreihe Kreislaufwirtschaft	1a, 1d, 2b, 2d, 2h, 3e	1

Provider	Focus /Info	Relevant offers	Competence areas[1]	CE Area[2]
	Einrichtung der Wiener Volkshochschulen GmbH	Schwerpunkt vor allem Beratung für Privatpersonen und Unternehmen; niederschwellige Bildungsangebote für ökologischen Lebensstil		
ZAB Zukunftsagentur Bau (ehemals Kompetenzzentrum Bauforschung KBF)	https://www.zukunft-bau.at/ Eigentümer: Österreichischer Baumeisterverband ÖBV Schwerpunkte: Bauforschung, Digitalisierung & Innovation, Bildung & Kommunikation für die österreichischen Baubetriebe	Weiterbildung, zum Beispiel zu Bauteilaktivierung, BIM, Energieeffizienz; in Kooperation mit BAUAkademien	1a, 1f	2
zt: akademie (ehemals Arch+Ing Akademie)	https://www.ztakademie.at/ der Kammer der Ziviltechniker:innen für W, NÖ, B	zum Beispiel Immobilien und Nachhaltigkeit: Green Deal, ESG, EU-Taxonomie; BIM-Training, Gebäudeintegrierte Photovoltaik, Bestandsbauten, Zirkulär Bauen	1a, 1c, 1f, 2b, 3e,	2

Source: Own representation
[1] Areas of competence: corresponding to Table 8: Representation of relevant competences for the conducted competence analysis
[2] Continuing education area: (1) governmental context; (2) communities; (3) market/product provider; (4) company

14.3 Appendix III: Evaluation of the national roadmap until 2020

The following chapter discusses the results of the analysis on the implementation of the measures outlined in the Austrian National Roadmap from the first BUILD UP Skills initiative (Fechner & Selinger, 2013), which were focused on the education and training of blue-collar workers in the building sector until 2020. The analysis was conducted in two team workshops, each with preceding and subsequent desktop research. The project team analyzed the five measures (M 1–5) and eleven accompanying measures (B 1–11) proposed in the roadmap with regard to activities carried out for implementation, the current implementation status and further relevance, as well as derived findings for the development of the new roadmap to 2030. The evaluation results and a conclusion are briefly presented below for each measure and accompanying measure.

M1 Coordination of the vocational training offer

Goal: Coordinated training offer, harmonized with the main actors for approximately 25,000 persons

Measure: Further training courses involving existing structures, for example, the framework of the Austrian Climate Protection initiative. The courses are conducted by educational institutions within the framework of cooperation agreements.

Result of the evaluation: The klima**aktiv** education program aims to support the education and training of professionals in the field of climate-friendly technologies and services towards a CO_2-free economy. In this context, the program aims to collect and publish in a structured way existing and planned training and continuing education programs for professionals in Austria in the fields of energy saving, renewable energies, building and renovation, and mobility. Current education and training courses for professionals in this field are continuously disseminated, for example, within the framework of klima**aktiv** Bildung (see also Chapter 5.5.4).

The current Just Transition action plan also specifically addresses the spatial distribution and networking of educational opportunities with the actions "Coordinate and communicate education and training needs and opportunities" and "Improve spatial distribution and networking of educational opportunities".

Conclusion: The coordination of continuing education is an ongoing task. This is also reflected in the programs klima**aktiv** and the Just Transition action plan.

M1_B1 Focused implementation of existing strategic plans

Goal: Use of existing strategy processes for BUILD UP Skills

Measure: The implementation status of the points of existing strategy plans (Austrian Strategy for Lifelong Learning, Master Plan Green Jobs, AMS Standing Committee on New Skills, Master Plan Human Resources Renewable Energy) is to be evaluated taking into account the thematic context and the target groups, and a corresponding implementation report is to be prepared.

Result of the evaluation:

Several strategies have been implemented in the area of education and training.

- Lifelong Learning Strategy 2020: The 2011 strategy aims to achieve strategic goals by 2020 based on ten action lines[128]. While not directly addressing the construction industry, the strategic objectives are still relevant (for example, catching up on degrees, learning-conducive work environment). A most recent monitoring report is available for 2017 (Hefler, et alii, 2018). Consequently, no further monitoring activities have been set.
- Master Plan Green Jobs: The Master Plan defines a growth target of green jobs until 2020[129]. So far, according to available information from the Federal Ministry for Climate Protection, there is an implementation report for the year 2015 (BMLFUW, 2016). The report shows a positive development of the environmental sector, which was helped by numerous public activities such as the renovation offensives, the klima**aktiv** initiative, or the action plan for sustainable public procurement.
- Master Plan Human Resources Renewable Energy: The Master Plan was published in 2013. No implementation or evaluation report is available.

Conclusion: Numerous strategies have been developed over the past decade. However, the impact of the strategies cannot be evaluated, because although goals were defined, hardly any activities were undertaken to evaluate the final achievement of the goals. Strategies need an appropriate commitment and a corresponding monitoring system so that they can be successfully implemented and evaluated.

M1_B2 Practice of granting powers in business licenses

Goal: Ensuring qualification via readjustment of the powers in the trade regulations

Measure: Decree that regulates the issuance of business licenses by the district authorities more precisely with regard to the required qualifications. The granting of business licenses is to be structured in such a way that the competence required for the energy-efficient execution of energy-relevant installations becomes a relevant criterion.

Result of the evaluation:

The granting of trade licenses is based on the Trade Regulation Act of 1994. Most recently, changes affecting the licenses of trade activities were largely implemented with the 2017 amendment to the Trade Regulation Act[130]. Numerous activities of independent trades in the area of construction were assigned to regulated trades.

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[128] Republic of Austria. (2011). Lifelong learning strategy in Austria. https://www.qualifikationsregister.at/wp-content/uploads/2018/11/Strategie1.pdf, retrieved on 27.02.2023

[129] Information on the website of the Ministry of Climate Protection: https://www.bmk.gv.at/themen/klima_umwelt/nachhaltigkeit/green_jobs/masterplan.html, retrieved on 27.02.2023

[130] https://www.wko.at/service/wirtschaftsrecht-gewerberecht/gewerbeordnungsnovelle-2017.html, retrieved on 28.02.2023.

Thus, the activities 1) cleaning up construction sites (for example, separating construction debris and waste according to recyclability), 2) dismantling and removing objects permanently attached to masonry in preparation for the demolition of buildings, and 3) sealing construction joints, which had previously been free trades, have been assigned to the regulated trade of master builders. Filling of already installed gypsum boards (formerly an independent trade) is now part of the plasterers and drywall finishers trade. Building sealers (sealers against moisture, pressurized water and drafts) have been assigned to the trade of heat, cold, sound, and fire insulators.

At the same time, new, uniform standards for master craftsperson and qualification examinations were defined to justify assignment to NQF level 6. The examination procedures are standardized and unified.

Conclusion: Individual changes have been made to the Trade Regulation Act that are aimed at improving the quality of execution in the area of sustainability in the construction industry. The unification and standardization of the master craftsperson and qualification examinations can also be expected to have a positive effect on the qualifications of those authorized to carry out the trade. Against the backdrop of current labor market developments, it is necessary to review continuously whether current adjustments to the trade regulations are necessary.

M1_B3 Use of labor market policy instruments

Goal: Use of labor market policy instruments

Measure: Support for employees in the sense of the AMS target "Support for career advancement" is an essential incentive for further training, especially in the target area of performers. It contributes to securing jobs; it should therefore be maintained in the new funding period.

The coordination of the New Skills initiative of the AMS (AMS Standing Committee on New Skills) with BUILD UP Skills and the Federation of Austrian Industries will take place in the follow-up workshops in the business cluster "Construction and construction ecology" in April 2013.

The use of funding opportunities for further training is to be increased through suitable measures, particularly in the area of information.

Result of the evaluation:

The Public Employment Service has numerous relevant programs here, a few of which are highlighted below.

- **AMS Standing Committee on New Skills**: The Standing Committee of the Public Employment Service Austria has been in existence since 2010. The initial aim was to anticipate foreseeable future developments on the labor market and to transfer them proactively into corresponding curricula for AMS continuing education measures. These were divided into different labor market areas, such as construction/building ecology and energy/environmental technology. Ecologization and green economy were central topics in 2013 and 2014, but in the following years, the Standing Committee curricula program was discontinued and replaced by research reports and New Skills interview

series. The thematic focus between 2015 and 2021 was heavily on processes of digitization. It was not until 2022 that the topic of "Green jobs, green economy" was brought back into focus.

- **Women in Technology (FiT)**[131]: This program has been running since 2006. The aim is to qualify women for skilled trades and technical occupations. Currently, the qualification in more than 200 different professions is promoted. Many of them are related to the qualification for sustainable building and renewable energy (for example, waste disposal and recycling specialist, structural engineering, electrical engineering, installation and building services engineering). Preliminary information and orientation offers are central elements of the program.
- **Career information, guidance and counseling**[132]: The AMS has established a variety of different information and counseling services tailored to different phases of life. These services range from an online interest test, to events in career information centers (Berufsinfozentren, BIZ), individual counseling for job seekers, and extensive occupational databases.

Conclusion: Proven labor market policy programs are currently being implemented to promote training and continuing education in technical occupational areas that are also relevant to the construction sector. In addition, labor market policy programs such as the environmental foundation[133] are being implemented, in which the AMS is involved as a key stakeholder. The focus here is on education and training for climate-relevant professions. Active labor market policy is an important instrument for accompanying the green transformation in the labor market.

M1_B4 Appropriate search engines for courses

Goal: Clarity of the course offering

Measure: Appropriate search engines for courses (does not apply to private education providers)

Result of the evaluation:

The extent to which the search engines used by education providers to search for professional development courses are aligned and updated is examined using the following publicly available databases:

- Continuing education database of the Public Employment Service Austria (AMS)[134]
- Course search of the Vienna Employment Promotion Fund (waff)[135]

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[131] https://www.ams.at/arbeitsuchende/karenz-und-wiedereinstieg/so-unterstuetzen-wir-ihren-wiedereinstieg/fit-frauen-in-handwerk-und-technik, retrieved on 28.02.2023
[132] https://www.ams.at/arbeitsuchende/aus-und-weiterbildung/berufsinformationen, retrieved on 28.02.2023
[133] https://www.aufleb.at/umweltstiftung/, retrieved on 28.02.2023
[134] https://www.weiterbildungsdatenbank.at, retrieved on 28.02.2023
[135] https://www.waff.at/kurssuche/, retrieved on 28.02.2023

- Course finder from ecotechnology Austria[136]

The AMS continuing education database lists suitable course titles, the institutes offering them, and current dates after entering the relevant keywords (for example, "energy efficiency in buildings", "building services engineering") and specifying the time and location. The waff database also provides the option of finding current courses offered by various institutes by entering keywords and, if necessary, subject restrictions.

Divided into different fields of interest, green education and training offers from various educational institutes can be searched for on the webpage of ecotechnology Austria. Dates and further information are displayed as virtual calendar entries. The search engines support the topic field 2 (companies, employees, job seekers), whereby companies, employees, and job seekers are supported in their training and continuing education needs and training and continuing education offers are shown.

Conclusion: It can be stated that search engine structures have been set up and are usable and that training and continuing education offerings can thus be easily researched. Search functions and filter options are structured differently and the content and organizational information displayed in each case is prepared in varying degrees of detail. A critical factor is that corresponding databases, search engines, and portals must be continuously maintained and updated in order to achieve the intended benefits.

M1_B5 Presentation of competences

Goal: Public presentation of demonstrable competences acquired through continuing education

Measure: Coordination of existing representations and establishment of an appropriate database for representation and promotion

Result of the evaluation:

Within the framework of the European project NEWCOM (2017–2020), a competence database was developed in order to make competences of professionals acquired through continuing education visible and comparable throughout Europe. Through this database, the competence acquired through further training can be linked to the skilled worker and thus made visible. By linking the competence database with the BUILD UP Skills advisor app[137], an already proven user interface was used to display personal competences in connection with continuing education. Subsequently, the combination of the competence database and the BUILD UP Skills advisor app was used and further developed within the framework of the European project BUSLeague (2020–2023).

Conclusion: The topic should be pursued further in any case. However, it must not be disregarded that a credible presentation of competences acquired through further training is associated with additional expenditure both for the training participant (competence

[136] https://www.ecotechnology.at/de/content/gruene-ausbildung-weiterbildung, retrieved on 28.02.2023
[137] https://play.google.com/store, retrieved on 28.02.2023

verification, longer training modules,...) and for the training provider (establishment of a system for the credible public presentation of the acquired competences, definition of examination modalities,...). In turn, these costs will only be borne by the participants if the further training offered is also demanded by the market (companies, end customers). An opportunity in this context may be offered by the general trend towards competence orientation in the education sector (compare Chapter 5.1.3).

M1_B6 Construction execution control

Goal: Improved control of construction according to plan in terms of energy relevance, as this is one of the most essential prerequisites for the increased use of continuing education

Measure: Ensure inspection as part of the official final acceptance (authorization for use); in federal states where a notification of completion is sufficient, appropriate random checks are to be carried out.

Result of the evaluation: The topic of "construction execution control" in connection with the guarantee of energy-efficient buildings was taken up and pursued within the framework of the national implementation of the European projects "BUILD UP Skills CrossCraft" and "NEWCOM". It turned out that especially the blower door test is an excellent possibility to control the correct building execution in connection with energy efficiency and to identify corresponding execution errors.

Conclusion: The obligatory performance of a blower door test in new buildings and in deep renovation, as well as further measures to ensure optimal designs in construction, are to be recommended and pursued further.

M1_B7 Recording of faults and damage as a basis for training (EASt)

Goal: Prevention of structural damage and faults

Measure: Expansion of building damage research

Result of the evaluation:

The recording of construction faults and structural damage and the monitoring in this area is carried out, on the one hand, by the construction companies themselves and, on the other hand, by externally or internally commissioned experts. In Austria, there are currently 1761 generally sworn and court-certified experts in the field of construction and building crafts listed on the website of the Ministry of Justice (justizonline.gv.at as of 20.3.2023).

Detailed data and analysis on the current state of structural damage in the Austrian construction industry could be used as a basis for improvement measures and provide concrete evidence for targeted research, training, and policy measures.

A new edition of a national building damage report (last edition: 2011; compare also Chapter 4.1.4) would be a possible basis for an analysis of the actual state of the construction fault and damage situation in Austria and could enable an allocation to trades. This could be used to develop targeted training courses related to trades and responsibilities.

Compared to 2013, there is an increased use of documentation software in building damage documentation and monitoring. Current technical developments increasingly enable new ways of recording and tracking building damage. For example, the use of mobile devices with suitable software support, thermal imaging cameras, drones, et cetera increasingly provide new ways to detect and document structural damage qualitatively and quantitatively. The use of sensors or fiber optic cables, for example, also provides further possibilities for detecting, locating and, above all, interpreting structural damage, especially in the case of long-term observations.

Individual documentation of faults of a construction project is delicate and confidential; the publication is usually not in the interest of the clients. This can be seen as a cause for the lack of available literature on construction faults in the Austrian construction industry. The skills shortage should be considered in this context, as should the problem of undeclared work.

Conclusion: There is a need for action. The reintroduction of a construction fault report or a tool for recording and publishing anonymized construction faults is recommended. The best practice approach tends not to be appropriate for this issue. A worst practice approach related to construction fault identification should be considered to highlight and publicize faults and avoid them in the future. The development of incentive schemes for the provision of construction fault data (for example, in relation to insurance) could be a future measure. In addition, the skills shortage is a serious problem in the construction industry. The identification of the causes of construction damage or the errors in the construction process serves to remedy them in a targeted manner through the development of appropriate training and measures.

M1_B8 Reduction of insurance premiums for qualification

Goal: Creation of incentives for further training through lower insurance premiums

Measure: Hold talks with the insurance companies

Result of the evaluation: In the context of the European follow-up projects (CrossCraft, NEWCOM ...), corresponding discussions were held with insurance companies. In principle, the insurance companies were quite open to the topic, but insufficient data availability (see M1_B7 Recording of faults and damage as a basis for training) as well as ambiguities in the coupling to the qualification of specialists led to the fact that the topic was not taken up by the insurance companies.

Conclusion: The measure is certainly of interest to insurance companies, but in order to follow it up, a better data basis is needed for the monetary evaluation of the construction damage currently occurring and its linkage to the qualification of specialists. By resuming the preparation of building damage reports (the last building damage report was published in 2011, see Chapter 4.2 Construction faults), there would be an opportunity to create a detailed and itemized data basis.

M1_B9 Quality requirements in public tenders

Goal: Clear quality requirements in public tenders

Measure: Review standard performance specifications and acceptance routines, implementation of procurement guidelines

Result of the evaluation: With the Austrian Action Plan for Sustainable Public Procurement (in short: naBe Action Plan), the public administration in Austria contributes to the achievement of this goal and takes important steps on the way to a climate-neutral administration. The public contracting authorities in the area of the federal government as well as sector contracting authorities apply the naBe criteria if they have received a corresponding instruction or a recommendation to this effect from their owner(s) or governing bodies. On June 23, 2021, the federal government adopted the updated naBe Action Plan, including naBe Core Criteria. After an evaluation and revision phase, 16 product groups were defined. These are provided in a compact criteria catalog.

Conclusion: The Austrian naBe Action Plan is an important step to advance the quality requirements in public tenders in connection with sustainability criteria. The goal should be that the naBe criteria associated with the action plan are also adopted or even exceeded by the federal states.

M1_B10 Updating job descriptions

Goal: Description of occupational profiles of energy-relevant competences in the construction sector

Measure: In order to update job descriptions with regard to the energy-relevant descriptions, a working group will be set up by the Federal Ministry of Labor and Economy with the participation of the social partners, the institute for educational research ibw, and the vocational schools.

Result of the evaluation:

In 2020, the amendment to the Vocational Training Act (BAG) introduced a statutory updating cycle of occupational profiles of five years in order to make regular adjustments to occupational profiles in line with labor market-specific requirements and technical developments. The continuously updated apprenticeship occupations are published on the website of the Federal Ministry of Labor and Economy in the form of apprenticeship occupation files.

Since 2020, learning objectives for sustainable work (environmental protection in the company, waste separation, resource-saving work) have been defined as standard for all newly updated or newly introduced occupational profiles in the competence area "Quality-oriented, safe, and sustainable work" with specific tailoring to the respective occupational area.

The extent to which sufficient energy-relevant competences are taught in the current occupational profiles of apprenticeships cannot be clearly shown based on occupational profile analyses. However, in the apprenticeship occupation of installation and building services engineering, especially in the main modules of gas and sanitary engineering and heating engineering as well as in the special module of eco-energy engineering, teaching contents are described that explicitly aim at imparting energy-relevant competences in the

construction sector (Verordnung Installations- und Gebäudetechnik – Ausbildungsordnung, 2008)

General recommendations with regard to future competences focus on apprenticeships and further training in the field of heating exchange or planning, installation of green energy technologies and especially of heat pumps, et cetera, as well as in the field of thermal building envelope refurbishment (Tretter, et alii, 2022, page 3). In addition, the integration of climate-relevant teaching content into existing courses is a key action in the topic area "Education sector" of the Just Transition action plan (Lindinger, et alii, 2023, page 11). The Environmental Foundation, a target group-oriented implacement foundation, established by the social partners Austrian Federation of Trade Unions (ÖGB) and the Austrian Federal Economic Chambers (WKO), is looking for partner companies that agree to impart climate-relevant qualifications to trainees.[138]

Conclusion: Job descriptions of apprenticeship occupations should be updated continuously and reviewed every five years. This provides the opportunity to supplement or strengthen energy-relevant topics for the development of competences with the support of experts. For example, since 2020, learning objectives for sustainable work have been defined in all newly introduced occupational profiles, with a specific focus on the respective occupational area. In this way, anchored positions on environmental protection could be given greater weight.

M1_B11 Training guides

Goal: Imparting energy-relevant competences through training companies

Measure: Prepare and distribute training guides for apprenticeship companies with practical instructions and special consideration of energy relevance for the apprenticeship trades bricklayer, carpenter, electrician, roofer, in addition to the guide for installation technology already being prepared

Result of the evaluation:

In occupation-specific training guides or manuals for in-company training, which are available for download on the "Quality in Apprenticeship" website[139] , tips and best practice examples from experienced trainers are explained in addition to training objectives and content (Qualität in der Lehre, 2022). Among other things, the occupations of installation and building services engineering, painter and coating technician, and bricklayer, which are relevant to the construction sector, are described in this way, along with other apprenticeship occupations. In the training guide and documentation for installation and building services engineering, renewable energy sources are addressed and reference is made to further documents from manufacturers and trade associations in the apprenticeship training on renewable energies.

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[138] https://www.ecotechnology.at/de/content/gruene-ausbildung-weiterbildung?etsv=kursfinder_at, retrieved on 22.02.2023

[139] https://www.qualitaet-lehre.at/downloads/ausbildungstools/ausbildungsleitfaeden/, retrieved on 29.04.2023

Conclusion: In addition to training objectives and content, the training guides contain numerous tips and best practice examples from experienced trainers. In addition to the ordinances of the Federal Ministry of Labor and Economy on the respective vocational training programs, the training guides also cover further training areas, for example, "Learning and working in the training company", in which topics such as "Working in the sense of conserving resources and the environment" are dealt with. Available training guides for other apprenticeships, such as bricklayers, carpenters, electricians, roofers, and installation and building technicians, would be desirable.

M2 Cross-trade vocational training

Goal: Contribution to building the skills of operators and skilled workers in the Austrian construction industry, which are necessary to achieve the nearly zero-energy building (NZEB) standards

Measure: Develop a broadly coordinated qualification concept

Result of the evaluation:

Especially within the European project "BUILD UP Skills CrossCraft" (2013–2016), work was done on qualification concepts for cross-trade training. However, corresponding further training offers were only accepted to a limited extent by the companies and skilled workers (lack of time of skilled workers and no direct professional benefits discernible). Therefore, within the framework of the follow-up projects (NEWCOM and BUSLeague), energy consultants were identified as the optimal target group for corresponding further training and relevant in-depth further training modules were developed with a focus on quality assurance in practice.

Job descriptions of apprenticeship occupations often include the item "Interdisciplinary training". Depending on the job description, reference should be made to interdisciplinary competences such as methodological competence, social competence, personal competence, communicative competence, working principles, and customer orientation. The possibility of additional integration of cross-occupational training objectives, particularly on climate-relevant topics, should be examined. This would also support "Topic 1: Education sector" of the Just Transition action plan, in particular Action B01 "Integrate climate-relevant teaching content into existing apprenticeships", which aims to make training adjustments in this regard (Lindinger, et alii, 2023, page 12).

Conclusion: Although the projects carried out have clearly shown that cross-trade training is needed in construction and that the topic should therefore be pursued further, more innovative approaches are required than simply offering appropriate training for skilled workers in order to establish the relevant know-how on the market.

M3 Construction quality assistant

Goal: Increase in the quality of construction

Measure: Develop the activity profile "Quality assistant in construction", a corresponding qualification, as well as an organizational concept in connection with company alliances

Result of the evaluation: As part of the European project "BUILD UP Skills CrossCraft" (2013–2016), a corresponding three-day training module entitled "Construction site quality coach" was developed. However, the offer was not accepted by the companies and skilled workers. Consequently, the contents for further training modules for energy consultants were revised within the framework of the follow-up projects NEWCOM and BUSLeague (see further training module "nZEB Building Coach").

Conclusion: Results of the projects carried out have shown that the establishment of a quality representative in construction (focus: sustainability and energy efficiency) could certainly contribute to an increase in the quality of execution, but there is currently hardly any corresponding market demand. If the topic is pursued further, it is important to develop new innovative approaches to establish a corresponding position in construction.

M4 Additional qualification for the inspection of heating and air conditioning systems (EAst)

Goal: Ensuring qualified personnel for the inspection of heating and ventilation and air conditioning systems

Measure: Clarification of the legal framework (powers) for the implementation of the inspections including the recommendation of the Building Directive for the combination of inspections and energy performance certificate issuance; review of the existing and additionally required competences for the recommendations on energy performance in inspection reports; implementation in training courses; development of corresponding further training courses. The further training courses can only be designed after the framework conditions have been defined; coordination between the federal states must be promoted in this regard.

Result of the evaluation: In all federal states, a specialized authority for the inspection and measurement of heating and air conditioning systems is prescribed in the respective specialized laws.

The range of basic and advanced training courses to become an inspector for heating and air conditioning systems varies between the federal states. WIFI in Burgenland, Carinthia, Upper Austria, and Styria, for example, offers such courses. The course "Stmk. Heizungs- und Klimaanlagengesetz – Fortbildungsveranstaltung für Sachverständige nach § 27 StHKanlG 2021" of the WIFI Styria (advanced training for experts according to §27 of the Styrian Heating and Air Conditioning Act 2021) must be completed every three years in order to be allowed to continue the expert activity for heating and air conditioning systems. In Tyrol, Carinthia, Vorarlberg, Upper Austria, Salzburg, and Vienna, the interval for completing a further training course is five years.

Due to different state laws on the inspection of heating and air conditioning systems, the necessary training and authorizations are also different. Differences in the intervals of continuing education and training can lead to differences in the topicality of the information passed on.

One hundred and sixty-nine sworn and court-certified experts in the field of heating and ventilation and air conditioning systems are registered in Austria according to a query on Justizonline (https://justizonline.gv.at/) on 14.4.2023. In addition, the inspections are carried

out by other persons authorized under provincial laws, such as chimney sweeps, tradesmen, civil engineers and engineering offices with relevant authority, who must complete further training at specified intervals.

Conclusion: The measures proposed in the Roadmap 2013 for additional qualification for the inspection of air conditioning and heating systems have mostly been taken up and are being implemented. The respective state laws on heating and air conditioning systems include the aspect of energy efficiency in addition to the aspect of safety engineering. In order to position the competences for the preparation of recommendations on the overall energy efficiency of buildings in the inspection reports and the connection to the energy certificate more strongly, primarily for systems with an output of less than 70 kW, the inclusion of experts on this topic in the mandatory further training courses would be recommended.

M5 Continuing education of teaching staff at vocational schools

Goal: Ensuring that teaching staff is up to date

Measure: Further development of offers of pedagogical universities for vocational school teachers, recommendation to training providers and funding agencies (ensure proof of appropriate further training, offer of appropriate "train the trainer" seminars)

Result of the evaluation:

Teachers can obtain further qualifications in addition to those already acquired in teacher training. Continuing education offers are often linked to new credentials. The strong differentiation of the vocational school system results in the need for nationwide coordination of continuing education and training for educators. The planning and coordination of these offerings takes place in close cooperation between the teacher training colleges (BMBWF, 2022).

Sustainability and energy efficiency is one of the further training topics recommended for vocational teachers in order to keep up to date with pedagogical and didactic approaches.[140]

Further training courses of teacher training colleges for teachers at polytechnic schools concern, for example, electrical engineering, installation technology, and renewable energies (BMBWF, 2022).

An obligation to provide further training cannot be derived. However, the integration of climate-relevant teaching content into existing apprenticeship training programs is an important component of the Just Transition action plan in "Topic 1: Education sector" in the field of action "Education and training and infrastructure offensive". The further training of trainers in climate-relevant apprenticeships is to be accelerated (Lindinger, et alii, 2023, page 13).

Conclusion: In terms of professionalization, it is necessary for educators to keep up with the latest developments in the areas of subject knowledge, subject didactics, and pedagogy. In

[140] https://www.bic.at/berufsinformation.php?be, retrieved on 24.02.2023

order to meet this requirement, appropriate instruments (incentives, commitments, et cetera) must be developed and applied with the actors involved.

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