energy innovation austria

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Current developments
and examples
of sustainable energy
technologies

klima+ energie fonds

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

Innovative construction

resource-friendly, energy efficient and climate-neutral

Many forward-looking developments have been implemented in the building sector in Austria in recent years to improve the energy efficiency and ecological sustainability of buildings. Innovative technologies and concepts for sustainable construction of new buildings and renovation aim to consider the entire life cycle of a building and drastically reduce climate-damaging emissions in all phases – from construction and use to deconstruction and recycling.

Photo: Mischek/Eva Kelety

Sustainability in the construction sector

Strategies and concepts: from planning to deconstruction

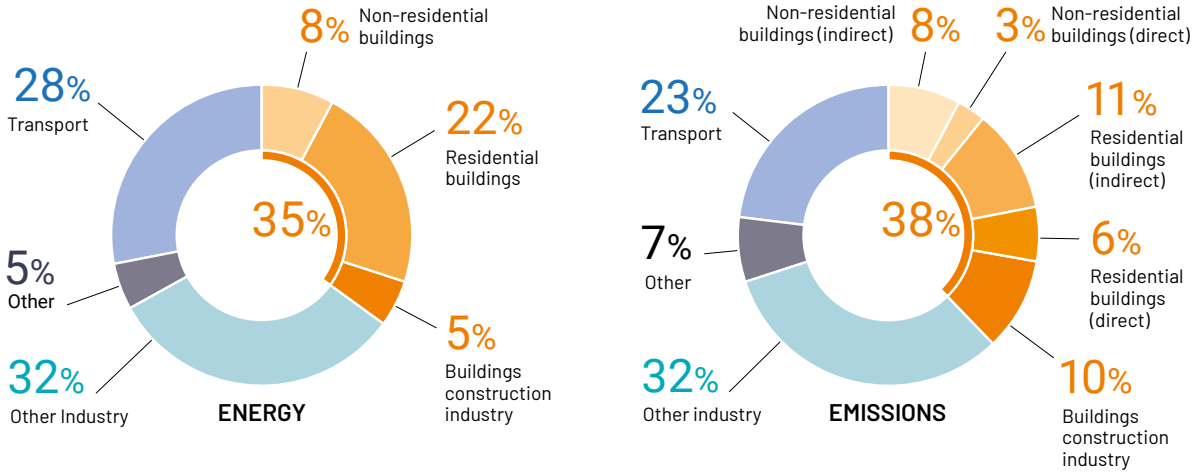
Significant amounts of energy and resources are necessary to build, live in and renovate buildings.

A high share of energy consumption and environmentally harmful emissions around the world can be traced back to the construction and building sector. According to the UN Environment Programme's "2020 Global Status Report for Buildings and Construction"[1], the construction industry accounts for 38% of global CO_2 emissions. To achieve a zero-carbon building stock by 2050, the International Energy Agency (IEA) estimates that direct building CO_2 emissions would need to decrease by 50% and indirect construction sector emissions by 60% by 2030.

The construction and renovation of buildings is also a core area of the European Green Deal, with which Europe has set itself the goal of achieving climate neutrality by 2050. The European Commission's 2020 strategy "A Renovation Wave for Europe"[2] foresees a doubling of energy-efficient renovations over the next 10 years. This should not only reduce greenhouse gas emissions and increase the quality of life in cities, but also create additional new jobs in the construction sector. The central guidelines for the renovation wave include the reduction of energy consumption, resource efficiency, circular economy and consideration of the entire life cycle of buildings.

BUILDING AND RENOVATING THE CITY OF TOMORROW

Austria has set itself the ambitious goal of being climate neutral as early as 2040. Innovations in the construction and building sector will be an important factor in reaching this goal. High-quality renovations and energy-efficient new buildings are the key to effective long-term climate protection. One of the major challenges for the construction sector is to find methods to construct and renovate buildings and entire neighbourhoods in the coming years in a way that will promote climate neutrality.



Global share of buildings and construction – final energy and emissions, 2019
Image: 2020 Global Status Report for Buildings and Construction, United Nations Environment Programme; adapted from "IEA World Energy Statistics and Balances" and "Energy Technology Perspectives" (IEA 2020d; IEA 2020b).
Note: The buildings construction industry is the portion (estimated) of overall industry devoted to manufacturing building construction materials such as steel, cement and glass.

Photo: stock.adobe.com

Synergetic, integrated, digital and circular solutions are needed to make buildings fit for the future. Research, innovation and technology development play a crucial role here.

Sustainable construction takes the entire life cycle of buildings into consideration and encompasses many different dimensions and measures. These include, for example, integrated planning methods, using recyclable building materials, resource-conserving and energy-efficient construction methods, sustainable smart energy systems based on renewable energy sources, flexible usage concepts and solutions for the deconstruction of buildings and/or recycling components and materials.

RESEARCH AND TECHNOLOGY DEVELOPMENT

For many years now, the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) has been supporting the research and development of technologies, system concepts and services for sustainable, climate-compatible and resource-saving urban spaces through the technology programme "City of Tomorrow". In 2021, the RTI initiative "Circular Economy" was launched to promote innovative R&D projects on relevant issues along the entire value chain.

In this issue, we present some current studies on the topic of "Innovative Construction" which were prepared within the framework of the "City of Tomorrow" research programme of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology. One pioneering example is the pilot project "Energy²POG – hybrid energy concept" on the Pogusch alpine pass. There, a hybrid and optimised overall concept with regard to operational material flows was implemented for the restaurant and hotel Steirereck-Pogusch as a flagship project with a model character for other businesses. ●

Photo: stock.adobe.com

https://nachhaltigwirtschaften.at/en/sdz/
https://nachhaltigwirtschaften.at/de/themen/kreislaufwirtschaft/

[1] globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf
[2] A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662

INTERNATIONAL COLLABORATION

Austria is actively involved in international research cooperation as part of the International Energy Agency (IEA) technology programme "Energy in Buildings and Communities" (EBC TPC). The programme aims to accelerate research and innovation to integrate energy-efficient and sustainable technologies in buildings and communities. Research topics include the development and trial of forward-looking building technologies for both new construction and renovation, building simulation programmes, energy management systems and sustainable energy supply concepts for communities and regions. Current projects with the Austrian participation deal, for example, with "Energy-flexible buildings towards resilient, low carbon energy systems", "Cost-effective building renovation at district level" and the "Assessing life cycle related environmental impacts caused by buildings".

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www.iea-ebc.org

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INCREASING THE RENOVATION RATE

Challenges for the construction industry

Despite the restrictions caused by the COVID pandemic, production volumes in the construction industry in Austria fell only slightly, totalling around EUR 40 billion in 2020. About a quarter of this was for building renovation. Current market assessments assume that the construction sector will remain an economic driver in the coming years.

Decarbonising the building sector will be an important cornerstone for achieving the national climate targets. The intensification of building renovation will play a central role in this process. The key figure for this is the renovation rate, which is currently 1.5% in Austrian residential construction. Austria is aiming to increase this rate to 3%. Thus, among other things, various measures were laid down in the government programme 2020[1] to help push the renovation rate up towards this target value and thus to improve the quality of renovation.

A new method for defining and measuring the residential renovation rate was presented in the spring of 2020 by the Environment Agency Austria together with the IIBW – Institute for Real Estate, Construction and Housing. The calculations according to this methodology show that it would be sufficient to increase the renovation rate from the current 1.5% to about twice that in order to renovate all the thermally insufficient housing stock in Austria until 2040.[2]

INCREASING CAPACITIES IN CONSTRUCTION

The objectives in the field of renovation pose great challenges for the construction industry. The demand for new construction is expected to remain good in the coming years. In order to be able to increase the renovation performance, the capacities of the construction and building products industry would therefore have to be expanded. To estimate the necessary volume, various scenarios have been calculated and the effects on the construction sector have been analysed in the new study "Increasing capacity in the construction industry to achieve a higher renovation rate" ("Kapazitätsanpassung der Bauwirtschaft für eine höhere Sanierungsrate") carried out by the Institute for Real Estate, Construction and Housing (IIBW) in cooperation with the Energy Institute at the Johannes Kepler University Linz.

Among several scenarios for building renovation, the one simulating increase in the renovation rate to 2.3% in 2023 and 2.8% in 2030 appears particularly interesting. Such a trend would not only sustainably support climate goals, but could also make a significant contribution to economic recovery in the wake of the COVID crisis. For the construction industry, however, it would mean an enormous expansion of the production volume in building renovation from the current level of approx. EUR 10 billion to EUR 16 billion by 2025. Annual increases of up to 15% would be necessary in this sector.

[1] Out of a Sense of Responsibility for Austria. Government Programme 2020-2040, p. 76 ff. bundeskanzleramt.gv.at/en/federal-chancellery/the-austrian-federal-government/government-documents.html

[2] iibw.at/documents/2020%20IIBW_UBA%20Sanierungsrate.pdf

> **"The decarbonisation of the Austrian building stock by 2040 seems feasible. However, it will require a bundle of measures. The priority is on funding incentives, housing and regulatory reforms. This study has shown that the limited capacities available to the construction industry could be a bottleneck. The production volume in building renovation must be increased by around two thirds in the medium term. If we want to have not only more but also better renovation projects, we need above all well-trained skilled workers. We have an excellent instrument in our hands with our dual-system vocational training. But we need many more apprentices in the field of construction. In terms of career, an apprenticeship offers everything you could want for a young person."**
>
> WOLFGANG AMANN,
> IIBW – INSTITUTE FOR REAL ESTATE, CONSTRUCTION AND HOUSING

Photo: IIBW – Institute for Real Estate, Construction and Housing

Aside from a scarcity of building products such as steel, wood and plastics, and bottlenecks in supply chains and logistics, labour shortages are a key barrier to the implementation of this scenario. According to the calculations, the ambitious path to more renovation projects would require about 17,000 additional employees in the construction sector. Retraining and hiring foreign workers or subcontractors are only possible to a limited extent. The analyses show that a sustainable expansion of the labour force potential can only be achieved through medium-to long-term solutions. The focus here should be on the further development of a dual education system.

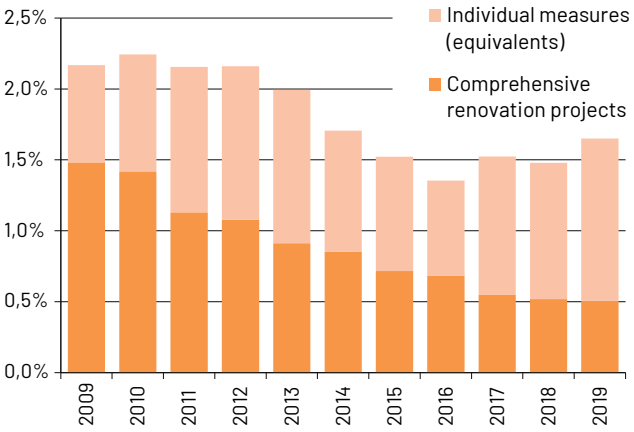
STRATEGIES AND MEASURES

Research and innovation play an important role in the sustainable development of the construction sector. The integration of new technologies and products can lead to trend-setting solutions not only in new buildings, but also in building renovation. Innovative developments include the prefabrication of building components, sustainable and recyclable materials and products, the optimisation of construction processes towards a CO_2-neutral construction site, and the use of digital technologies such as building information modelling (BIM) for the integrated, efficient planning and implementation of construction projects. Artificial intelligence, blockchain and robotics are currently being researched and tested in the construction sector.

The study proposes detailed measures (including legal framework conditions and subsidies) for both the large-volume construction sector and the large stock of owner-occupied homes that can support a planned expansion of building renovation. ●

https://nachhaltigwirtschaften.at/de/sdz/projekte/kapazitaetsanpassung-bauwirtschaft.php/

Total renovation rate



Definition of renovation rate acc. to Chap. 4.2.1., Image: IIBW & Environment Agency Austria (2020a), 2019: IIBW estimate.

Photo: stock.adobe.com

Recyclable solid construction materials

Opportunities and potentials of the circular economy



All photos: stock.adobe.com

Around half of the total resource consumption in Austria, 95 Mt per year, is accounted for by the use of non-metallic minerals and the raw materials used in the construction industry.[1] These building materials will continue to be used significantly in building construction and infrastructure construction in the future. In addition, it is to be expected that large quantities of construction waste will accumulate in the coming years due to the comprehensive renovation of the building stock. The necessary reduction of resource consumption and CO_2 emissions poses great challenges for the building materials industry. Decarbonisation and the transformation to a circular economy will require innovations along the entire value chain of the solid construction industry. In a recent study by the ÖGUT - Austrian Society for Environment and Technology[2], the requirements, opportunities and potentials of a "circular economy" for the solid construction industry were analysed and future fields of action for research and development were identified.

SOME CORE RESULTS OF THE ANALYSIS

> The recycling rate in the Austrian construction sector is already high at around 80% and primarily concerns asphalt and waste from underground construction projects. For the most part, the materials are downcycled. The residual masses are mainly used for road construction or as backfill material and are usually not recycled to a higher value. In building engineering, the recycling rate is only about 40%. In order to be able to use residual materials as a basis for high-quality, pollution-free recycling (recyclable) building materials, it is necessary to separate and process them by type. However, the increase in composite materials is making it more difficult to deconstruct building construction in this way.

> At this time, it is not economically viable to recycle solid construction materials. The low cost of primary raw materials and depositing the waste is offset by the high cost of transport and separating and processing the residual materials. Logistics and matching the time and place of the supply and demand are key factors influencing the economic viability of recyclable building materials.

> The sorting and processing of construction waste sometimes require a high energy input. It is also necessary to consider how environmentally-friendly the recycling processes are.

> One important aspect is the accumulation of pollutants in products and materials. Through consistent recycling over several building life cycles, pollutants can accumulate beyond the currently applicable limit values, and currently harmless components can become problematic substances in the future.

> Building information modelling (BIM) should be used to build and update material databases and overviews of the masses in all life cycle phases of a building structure and could support the use of regionally available residual materials from the construction industry.

> Involving all stakeholders along the entire value chain is one important prerequisite to increasing the recycling of materials used in solid construction. So far, there is little networking between the construction industry, the waste industry and the raw materials industry (including producers of building materials).

> The legal framework conditions (e.g. standardisation, waste legislation and the guarantee of recyclable building materials) will be decisive in making the recycling of materials in solid construction economically viable. The current construction regulations are rather restrictive, especially for the use of recyclable concrete. Legal restrictions also affect, among other things, the use of mobile treatment plants in urban areas. ●

https://nachhaltigwirtschaften.at/de/sdz/publikationen/schriftenreihe-2021-24-kreislauffaehigkeit-massivbaustoffe.php

[1] Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK): Resource Use in Austria 2020 – Volume 3. Vienna, August 2020.
[2] Anforderungen an die Kreislauffähigkeit von Massivbaustoffen (Requirements for the recyclability of materials used in solid construction), a study commissioned by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK), ÖGUT – Austrian Society for Environment and Technology, F. Trebut, B. Pfefferer, June 2021.

REQUIRED RESEARCH AND RECOMMENDATIONS FOR ACTION

In the course of the study, the required research and possible strategies for increasing the recycling of materials in solid construction were analysed and divided into three fields of action. For a transformation towards a circular economy, it will be necessary to develop new technological approaches, process innovations and new business models. The close networking of stakeholders along the entire process chain as well as the legal and normative framework conditions are of central importance. In its study, ÖGUT, the Austrian Society for Environment and Technology, has compiled detailed research topics in all these fields of action to promote the recycling of materials used in solid construction.

Image: ÖGUT – Austrian Society for Environment and Technology

SUSTAINABLE OVERALL CONCEPT

Energy²POG – Hybrid energy concept for Steirereck/Pogusch

In the hotel and restaurant business, the consumption of energy and resources is an important production factor that causes high costs and CO_2 emissions. There are complex flows of materials involved in the operation of hotels and tourism facilities. Up until now, new construction and renovation in this sector usually only considered individual, isolated components, and synergy potentials have rarely been exploited.

A pioneering flagship eco-project was implemented with the reorientation of the "Steirereck am Pogusch" restaurant and hotel business in an exposed, isolated location at around 1,100 metres above sea level. Under the project name "Energy²POG", the facility operators, the Reitbauer family, implemented an exemplary positive energy ensemble with a sustainable and ecological overall concept[1]. To do this, the existing construction (a main building and several outbuildings) was energetically optimised and extended by innovative new additions.

The optimised concept enables the integration of all operational material flows. The focus was on a renewable energy supply (heating, cooling, electricity) and was complemented by numerous measures to reduce resource consumption and minimise mobility-related energy and CO_2 emissions. Energy²POG demonstrates how a comprehensive package of measures can be used to realise an almost energy-autonomous, resource-friendly tourism project. The project is a best practice example and the overall concept can also be applied in urban areas.

RESOURCE CONSERVATION AND CIRCULAR ECONOMY

The aim of the building concept was to achieve a resource-friendly, energy-efficient construction (e.g. a high insulation standard and optimal zoning of the heated areas) as well as a careful revitalisation and optimal use of the existing buildings. The kitchen, sleeping areas, stone house, wooden house and agriculture have all been expanded, revitalized and supplemented with new elements (including two glass houses as well as special buildings for staff and guest accommodation such as tree houses). Despite the diversity of the buildings and special usage requirements, great importance was attached to the quality of the overall structure. One of the principles of the "Steirereck am Pogusch" operation is to use as many local resources as possible. For example, components are manufactured in-house and parts or furniture are repaired and reused. Depending on the building substance and costs, mainly ecological building materials were used for the renovation.

INNOVATIVE ENERGY CONCEPT

The "hybrid energy concept" is based on the interplay and optimisation of different renewable energy systems and relies on the use of solar energy, regional biomass and passive components. The already existing supply systems have been integrated with newly constructed systems to form an overall solution.

[1] **PROJECT PARTNERS**: AEE INTEC (project management), Steirereck-Stadtpark GmbH, TBH Ingenieur GmbH, PPAG Architekten

The diverse local food production is one central aspect. The enterprise operates sustainable agriculture to achieve partial self-sufficiency. Fruit and vegetables are grown in open spaces and in the newly constructed glass houses that are integrated into the building. The greenhouses have been designed to meet a high thermal standard and strictly separated into a part that is moderately heated, and another one kept at a low temperature.

All photos: Steirereck-Stadtpark GmbH

A biomass CHP plant with around 100 kW thermal and 50 kW electrical power will be used as a supplement. The new buildings have been designed in accordance with the low-energy standard and partly with passive house components and equipped with controlled ventilation systems including heat recovery. Heat is distributed via low-temperature systems, e.g. underfloor and wall heating, as well as extensive thermally activated building systems in the floor and ceiling surfaces.

Neither existing buildings nor new construction areas are actively air-conditioned; instead, the natural climatic conditions at an altitude of 1,100 metres are used to pre-condition the fresh air (e.g. air collectors) or, in summer, to use the cool outside air to cool down the building-storage mass. With this integrated energy concept, a positive energy standard is achieved for the entire "Steirereck am Pogusch" property.

ENERGY STORAGE AND SMART REGULATION

In order to achieve a high degree of self-sufficiency with the renewable energy that is generated on site, and to be able to compensate for the restaurant's fluctuating load profiles, the following components were installed to store the energy and for smart regulation of its generation and consumption:

- heating buffer tank (38.5 m^3)
- drinking water reservoir (approx. 70 m^3)
- service water cisterns (approx. 40 m^3) for rainwater utilisation
- thermal activation of concrete and foundation components
- stationary battery storage system (approx. 80 kVA) (planned)
- load and energy management for the power consumption systems
- mobile battery storage from electric vehicles (planned)
- smart regulation concept
- heat recovery from commercial refrigeration systems
- waste heat recovery from wood stoves

https://nachhaltigwirtschaften.at/en/sdz/projects/energy2pog.php

> **"With the support of our partners, we have been able to successfully fulfil our wish to create a functioning circular economy at Pogusch, not only for the agricultural and catering sectors but also for the energy sector."**

BIRGIT UND HEINZ REITBAUER
MANAGEMENT STEIRERECK-STADTPARK GMBH

Photo: Philipp Horak/Steirereck-Stadtpark GmbH

Photo: stock.adobe.com

CO_2-NEUTRAL CONSTRUCTION SITE

Measures to reduce emissions in construction

While there has been significant progress in energy-efficient construction as well as ecological building materials and recycling in recent years, the environmental impact of construction activity itself has received little attention to date. A recent study by the Resource Management Agency (RMA) and the TU Wien[1] focuses on this aspect. Within the scope of the analysis, all directly and indirectly generated CO_2 emissions on urban construction sites were identified and methods, technologies and framework conditions for their substitution, compensation and adaptation were shown. These methods include reducing CO_2 emissions by shortening the construction time, and optimisation of the process chain in connection with practices such as lean management, as well as CO_2 credits for using on-site resources, for example, urban mining.

To account for the emissions, construction sites were broken down into individual processes. The respective process steps were assigned to diesel and electricity consumption, transport kilometres or other emission sources. In practice, emissions depend on many other factors as well, such as the location of the construction site, the size of the construction equipment, the construction site logistics and the construction methods used. For the accounting, four fictitious construction sites were taken as samples (building construction, road construction, renovation and demolition site) were defined. Their emissions fully calculated with the help of an expert tool developed in the project.

STRATEGIES FOR NEUTRALISATION

Optimisations in the construction process and the use of low-carbon equipment, machinery and vehicles are the primary strategies to reduce emissions on the construction site. An important measure to reduce CO_2 emissions is replacing fossil-based electricity from the grid with locally generated or purchased electricity from renewable sources. Emissions that cannot be reduced to zero should be offset externally as an ultimate step. The study evaluated the different strategies regarding technological availability, effectiveness, implementation costs and realisation complexity. The processes of the model construction sites were compared with the identified measures.

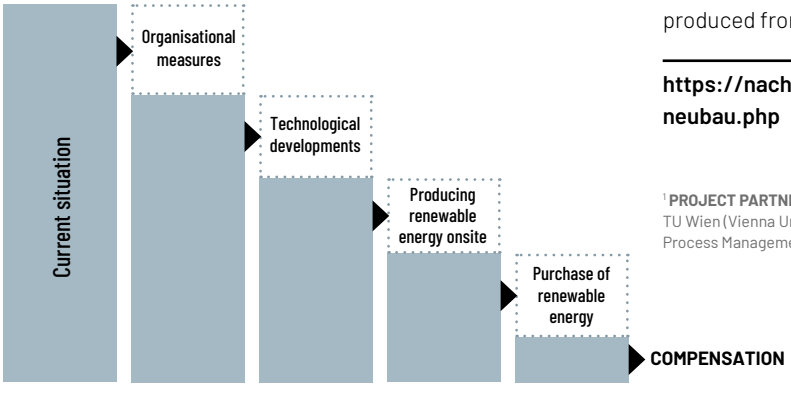


Chart: RMA

RESULTS AND POTENTIALS

The scenarios for the four model construction sites show ambitious possibilities for reducing greenhouse gases that can be implemented in the short term. From a business perspective, however, not all of these can be considered cost-neutral. The road construction site has the lowest savings potential at approx. 20%. This is due to the more energy-efficient construction processes and machinery. For the demolition site - which has a high transport share – a savings potential of 25-30% was calculated, which could be even higher with more reused on-site mineral demolition material. In the electricity-intensive renovation site, the savings potential - mainly through the purchase of renewable energies - is just under half of the emissions. The CO_2 emissions of the building construction site could be reduced by more than half. Two-thirds of these results would be due to shortening the transport distances.

Alternative drives for construction machinery and transport vehicles are an effective measure to reduce CO_2 emissions. Possible sustainable drives of the future are electric power (in batteries, or for stationary construction equipment also via cable), hydrogen/fuel cells, fuels from biomass (as support or transitional solution) and e-fuels (combustion fuels synthetically produced from green electricity). ●

https://nachhaltigwirtschaften.at/en/sdz/projects/co2-neubau.php

[1] **PROJECT PARTNERS**: Resource Management Agency (RMA) (project management), TU Wien (Vienna University of Technology) - Institute for Interdisciplinary Construction Process Management, Department of Construction Process and Methods

Digitalisation in the Austrian construction industry

Effects on the labour market

A current trend analysis carried out by the Working Life Research Centre (FORBA) investigated what effects on the sectoral labour market in Austria can be expected from the digital transformation in the construction sector. The effects on the labour and employment market for the next five to ten years could be estimated based on literature research, media analyses and interviews with experts from the Austrian construction industry.

In recent years, there have been many reports in trade journals about digital applications in the construction sector – from construction site apps and the more efficient exchange of information through building information modelling (BIM) to robotic applications such as drones, 3D printing, etc. In practice, these innovative technologies are being implemented very slowly and gradually, and so far in Austria they have mainly been used in larger pilot projects. Job losses due to the digital transformation are therefore unlikely in the construction sector in the next few years. Many processes in the construction industry are fragmented and are therefore labour-intensive and difficult to automate. In general, the work processes on construction sites are less easy to standardise than in stationary production. The conclusion of the study is that the increasing spread of digital applications in the construction industry is not likely to become a job killer, but also not a job bringer.

The following developments on the labour market are to be expected:

- Stability to slight increase in employment in highly qualified non-manual work of civil engineers, IT specialists, etc.
- Tendency towards less non-manual (office) routine activities for employees
- Stability of employment among skilled workers in construction occupations
- Decrease in employment in semi-skilled and unskilled manual labour in the construction industry

When discussing technological rationalisation potentials, a differentiation must be made between "software" (e.g. BIM, AI) and "hardware" (e.g. 3D printing, robotics) as well as between manual and non-manual work. In the medium term, the quantitatively more relevant potentials lie in the automation of manual activities, especially in standardisability in the context of offsite component prefabrication (supported by computer-based precision).

A major challenge for the construction industry in the coming years will remain the frequently expressed shortage of skilled workers, which relates primarily to young and well-trained workers in apprenticeships. Digital applications could be used in this respect in the future to compensate for a lack of skilled workers through increased use of technology.

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An important economic driver from which the construction industry and ancillary construction trades will benefit in the coming years is climate and environmental protection. The necessary conversion of buildings and infrastructures in the direction of decarbonisation (including the replacement of oil and gas heating systems, thermal renovation, expansion of photovoltaics, etc.) creates great potential for the industry. In addition, an increasing demand for repair work of damage caused by climate-related extreme weather events is to be expected. ●

https://nachhaltigwirtschaften.at/en/sdz/projects/forba-study-digital-transformation-construction-industry.php

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INFORMATION

Increasing capacity in the construction industry to achieve a higher renovation rate
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Requirements for the recyclability of materials used in solid construction
ÖGUT – Austrian Society for Environment and Technology
on behalf of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)
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Energy²POG – Hybrid energy concept for Steirereck/Pogusch
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CO_2-neutral construction site
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Digital transformation of the Austrian construction industry and effects on the workforce
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IEA Energy in Buildings and Communities Programme (EBC TCP)
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