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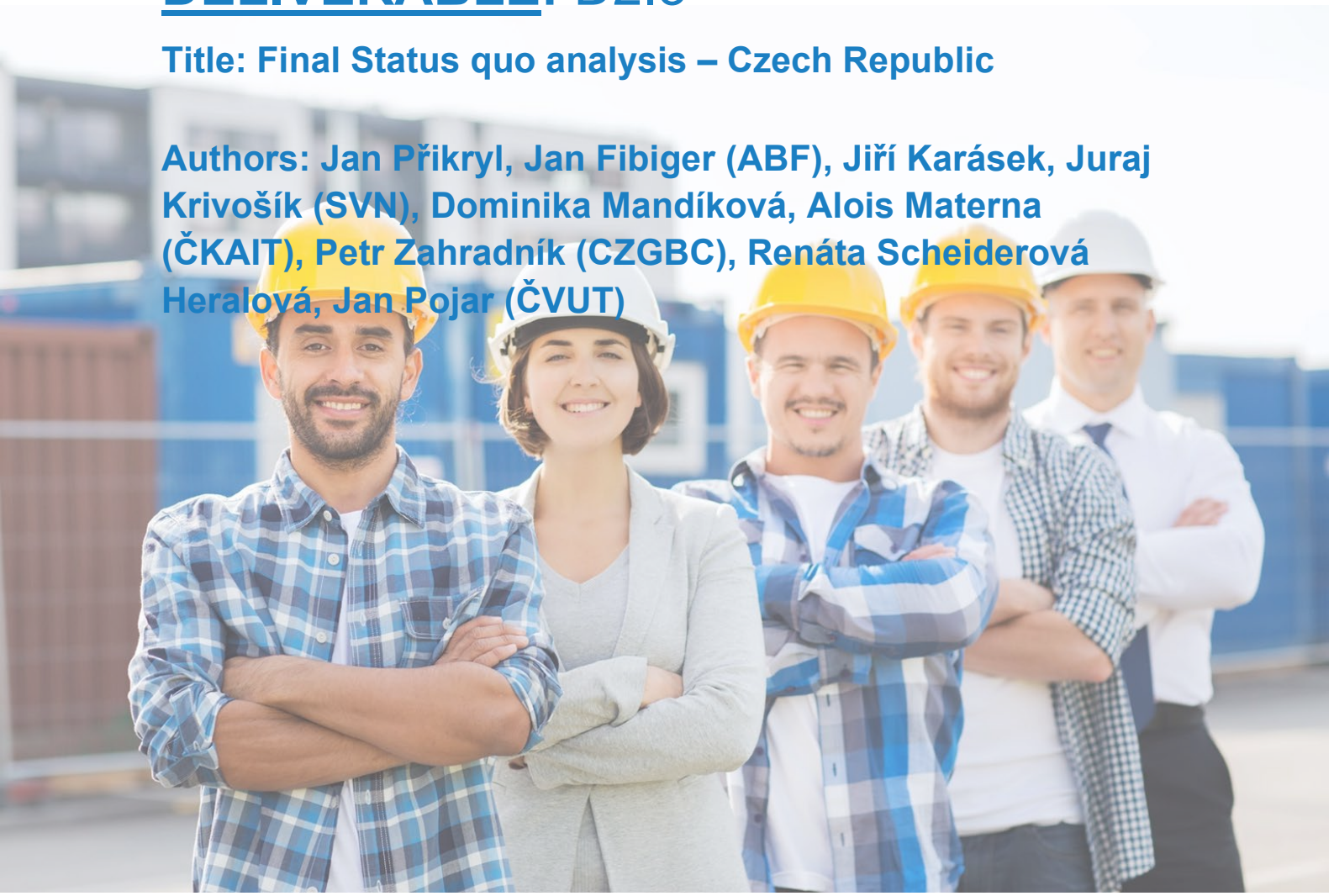

Build up Skills (BUS) initiative in CZ and SK –

Rebooting the National qualification platforms and Roadmaps towards implementation of nearly Zero Energy Buildings and support for Renovation Wave

Project Number: 101077450; DoubleDecker

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Disclaimer

Further information

More details on BUILD UP Skills can be found at https://build-up.ec.europa.eu

More details on the LIFE CET programme can be found at https://cinea.ec.europa.eu/programmes/life_en

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Summary

The construction industry has had a long-term significant impact on the state and development of the Czech economy as well as the social environment, including the related **environmental** and socio-cultural aspects of development, as:

- it steadily generates around 5 to 6 % gross domestic product;
- it steadily employs approximately **7 to 8 % of people working in the construction sector**. In 2022, the number of people employed in the construction sector reached approximately 417 thousand people. This is an increase of 14 thousand people (7,7 % of the total number employees in the national economy), which is probably caused by the influx of workers from Ukraine. Nevertheless, the construction sector in the Czech Republic has been concerned with the problem of **labour shortages**, both in the field of skilled and unskilled labour;
- it steadily shows a substantial **multiplier effect** on a number of areas of the manufacturing sector, although this effect has been declining in recent years (the construction sector saw a multiplier effect with an index between **3.2 and 3.5** in 2010, but is now reported to be between **2.3 and 2.6**, both depending on the type of construction investment);
- construction projects use a major share of raw materials and energy resources:
  - **extraction of construction raw materials** and minerals for the production of building materials represents more than **50% of total domestic extraction**, with some sources approaching their limits (aggregates, sand) and a growing share of **imports**;
  - **buildings** are responsible for about **40% of total energy consumption** and about the same percentage of greenhouse gas emissions (mainly CO_2) and solid waste production. This savings potential is addressed by the EED, RES and EPBD Directives, which aim to increase the energy efficiency of the building stock. The EPBD has been incorporated in Act No 406/2000 Coll. on Energy Management, which amends Act No 3/2020 Coll. and its implementing regulation, Decree 264/2020 Coll. on the energy performance of buildings. The EED and RES directives are also reflected in Act No 406/2000 Coll. and in the Czech Republic's National Energy and Climate Plan;
- public procurement has a significant and irreplaceable impact on the development of building production within domestic procurement. The share in domestic procurement reached **58 % in 2022**, when the value rose to CZK 150 billion;

- the Czech Republic is characterised by a high level of self help, which is reflected in a very dense network of hobby stores (e.g. Bauhaus, OBI, Baumax, Hornbach), construction supplies stores, garden centres, bathroom and kitchen studios. Moreover, this area was significantly activated in the period of the Covid-19 pandemic;
- a very high level of responsibility is imposed on building contractors, which also predetermines a high **level of regulation and involvement on the part of the public administration**.

Above all, however, it is necessary to point out the **strong links between the construction and energy sectors**, both in energy consumption (including measures to ensure energy savings in the building operation) and in the implementation of plans for the renewal and development of energy capacities as part of the State energy policy.

The emphasis on the principles of energy-efficient construction will require continuous preparation and implementation of all kinds of innovations in construction companies: technical, technological, organizational and commercial. In this context, extraordinary demands will be imposed on the growth of the quality of management at the level of individual companies, as well as on the growth of the effectiveness of the regulatory environment and conceptual coordination by the public administration.

The structure of the construction industry will change towards reduction of market fragmentation. The position of large integrated companies and medium-sized specialized companies will be reinforced. At the same time, the market will be partially "purged ", i.e. some financially, staff wise and technologically weaker business entities will disappear. The growth in labour productivity will be accompanied by a reduction in costs, not only the construction works but also in the building operation.

In line with EU energy saving and climate policy objectives, less material-intensive and more energy-efficient buildings will also be encouraged. On the one hand, this means maintaining a high share of energy producing buildings in the total volume of construction production, but it will also significantly increase the demand for maintenance and renovations, which will create an opportunity especially for smaller companies in the sector. New progressive materials and building elements, supported by the use of modern technologies, will be massively promoted in connection with the change in the structure of demand. There will be a streamlining of construction production and a change in management approaches towards the concept of 'lean construction'. The use of information and communication technologies in the sector will increase.

The pressure to improve the energy performance of buildings (both existing and newly constructed) has a major impact on both the production profile of the Czech construction sector and on the demands for the **qualifications of its workers** and this impact is going to be even greater in the future. The demand for energy-efficient construction, along with the need to increase labour productivity, demands multiple qualitative improvements on the **education sector in the construction sector**.

Adult education will play a key role in this. This is due to the following factors:

- Demographic trends, which will result in a slight increase in the number of people of secondary education age (15-19 years) by around 80,000 by 2030, although this number will not reach the peak level of 2010;
- Lack of interest among young people in training for trade occupations in the building sector: the situation is currently slightly improving, but even so, only about 12,000 pupils are being trained in all years of vocational schools (apprenticeships) focused on occupations within the construction sector. The number of graduates therefore barely covers the number of qualified construction workers retiring each year or moving to other sectors;
- Significant number of construction apprenticeships and secondary vocational schools graduates leave the industry upon graduation to work in another sector. Thus, around 40% of secondary school graduates work outside their field of study within a few years of graduation.

As far as adult education in the construction sector (and related professions) is concerned, it is still very fragmented in the Czech Republic with regard to content and organization. In terms of content, implementation of the National Qualifications System and the National System of Occupations promise methodological unification. So far, however, these systems have not proved to be fully effective.

Currently, on average, only about a third of all workers in the construction sector receive some form of training each year, and this is often inconsistent, or only touching upon partial aspects of the profession.

The problem of adaptation of the Czech construction sector to new challenges, including the growing demands for energy-efficient construction. To solve this problem, it is necessary to increase the capacity of primary education and education of professionals by 10 % and 30 %, restively, to 2030.

Although the issue of saturating the needs of the construction sector in the fields of craft work in the Czech Republic is topical and urgent, equally important, though difficult to quantify, is

the issue of raising university-educated workers for (zero emission) construction, responding to revolutionary technological changes in the field (digitalization, application of AI, etc.).

However, there are number of **obstacles** on the way to the defined quantitative and qualitative goals of increasing the qualification profile of construction workers. The most important ones include:

- Absence of a unified construction management system, including strategic management;
- Poor labour productivity in the construction sector;
- Pressure of companies to use unskilled workers due to labour cost savings;
- Low quality of management;
- Low interest of young people in training in the field;
- Low interest in adult education in the skilled trades (low motivation);
- Unpredictability of the legislative environment.

The main obstacle to the implementation of structural changes in employment in the construction industry is the **absence of the necessary statistical data**. Therefore, table below is based on data estimates from the construction sector.

Table 0: Summary of data from the construction sector

Economics			
Share of construction sector in the national economy (2022)		5.63%	
Share of the sector in the national employment (2022)		7.49%	
Share of public procurements in the construction sector (2022)		58%	
Increase in skilled workforce (2022- 2030) in thousands			
Newly entering qualified secondary school and university graduates		+ 20	
Newly entering qualified workers from other sectors		+ 15	
Increase in qualified workers due to continuing education		+ 40	
Increase according to construction professions	2022	2030	
Masonry (Masons, bricklayers, tilers and installers of dry structures)	104.6	108.8	4 %
Isolation	9.7	10.7	10 %
Chimney	3.4	3.4	2 %
Plumbing, heating	38.9	39.3	1 %
Stove-making, Mechanics of air conditioning and refrigeration equipment	4.6	4.8	5 %
Painting, varnishing	22.2	22.1	-0.5 %
Roofing, carpentry	25.8	25.8	0

Project activity under construction	56.2	55.1	-2 %
Implementation of constructions, their changes and removal, Managers	69.0	67.6	-2 %
Construction and operational electricians	7.4	7.6	3 %
Foremen and related workers in the construction industry	12.4	12.3	-0.5 %
Workers in the field of building construction	17.3	16.5	-5 %
Others	30.7	30.7	0
TOTAL	402.2	404.7	+0.6%

1. Introduction

1.1. Competences in the field of energy-efficient construction and education

In terms of competences, the area of construction, energy and energy-saving, construction sector is divided among several ministries at the level of the Government of the Czech Republic. The Ministry of Industry and Trade is responsible for building materials, construction sector, energy including energy legislation and regulation, and business environment. The Ministry of Regional Development is responsible for urban planning and building regulations, housing policy, regional development, European funds and public procurement legislation. The Ministry of the Environment provides environmental policy (including environmental impact assessments), water protection, environmental and ecological damage management, air protection, climate protection and waste issues. Its subsidy programmes most intensively support energy-saving solutions in civil and residential construction. In this context, the Ministry of Finance, which prepares draft state budgets and state fund budgets, is also important. The Ministry of the Interior then provides the education system for civil servants. The Ministry of Culture ensures the care of cultural heritage, of building monuments, which represent a significant proportion of the buildings in the historic cores of most Czech cities and towns. The Ministries of Transport and Agriculture then administer the construction of transport buildings and water management facilities. The Ministry of Education, Youth and Sports ensures the conditions for pre-school, primary, secondary and vocational education, as well as university education. The traditional education system is administered **separately from the construction industry itself and from the state's programmatic policies on construction**, which often causes the system to lag behind the needs of construction practice. The issue of lifelong learning is addressed separately. It is regulated only in the case of engineering and technical professions by Act 360/1992 Coll. on the exercise of the profession of authorized architects and on the exercise of authorized engineers and technicians active in construction, and for some vocational and trade professions including fire protection, energy audits, electrical installation work, gas installation, etc. In the case of trade professions, this issue is inconsistently ensured by the voluntary activity of professional guilds or by targeted promotion of some manufacturers of building materials and products for construction.

The practice gradually brings new requirements for knowledge and skills, especially the expected changes related to the quality requirements of work with new products, technologies, design solutions. To quantify these requirements and to define the requirements for the training of workers in the building and construction sector is one of the basic tasks of this SQA.

1.2. Ongoing and expected changes

Not only the Czech construction sector but also the European one is at a crossroads. The current lack of production capacity, the disruption of supply chains, the unaffordability of housing for the young and the generally slow response to technological and social change are just some of the trends that are creating pressure for an accelerated **transformation of the construction sector**. This sector, which directly employs more than 13 million workers in the EU, is also one of the key sectors in the fight against climate change. If the construction sector is to retain its important position in society and the economy, it must undergo structural change across the entire value chain, with a focus on increasing labour productivity, speeding up the construction process and making the sector more attractive to recruit new workers.

The sector has to deal with several challenges at the same moment. First, it needs to replace the missing workers in the industry and simultaneously improve the attractiveness of the sector. Furthermore, in the area of energy savings, the construction sector will implement comprehensive renovations of our housing stock – the key to increasing energy performance of buildings in the Czech Republic. In addition, the construction sector must prepare for the increasingly rapid evolution of technology and a stronger perception of the carbon footprint of products, all the way through the manufacturing and supply chain to on-site installation.

The transformation will take place in the current and next decade and will lead to profound structural changes in the sector, to the decline of some trades and the creation of entirely new attractive positions. This will result in an increase in the share of industrial production and automation in the sector, as well as an increase in standardization and the use of the principles of typification of structural and functional parts of buildings using AI and robotics.

Apart from listed buildings and buildings of great cultural value, the renovation of existing buildings and especially new buildings will be subject to pressure to introduce new construction methods.

The most crucial starting point for the transformation of the construction sector will be digitalization, “industrialization” of the sector and adaptation to a changing ecosystem. Modularization, reinforced capacities for the production of construction products, artificial intelligence in production planning and logistics, which we already know from the automotive industry, for example, will change the construction sector in several aspects. The need for **digital literacy** in the construction professions with regard to working within a digital model of construction and its blending with reality will increase significantly. Increasingly, specializations of workers within the creation and use of the digital construction model are emerging. From these, as yet non-existent professions will be recruited to preserve and disseminate information throughout the construction lifecycle. The construction sector will see the rise of very high value-added positions related to the digital transformation in the sector and the

repeatability of the outputs produced. At the same time, the appropriate adaptation of construction legislation and permitting processes will be a prerequisite and necessity.

2. Objectives and methodology

The aim of the present National Analysis of the current state of the art was to document the legislative conditions, the management environment of the entire construction sector (including human resources management), to evaluate the effectiveness of the individual education systems and levels, based on the assessment of the statistical data available and available forecasts and studies addressing particular partial issues, to synthesize this knowledge and formulate theses and requirements and then to verify these conclusions at a meeting with representatives of the sector (national qualification platform).

As the team of authors consisted of experts from several organizations, it was possible on the one hand to cover a relatively broad view of the addressed issue, on the other hand, it was necessary to unify the starting positions, methods of evaluation and comparison of sometimes inconsistent input data in a series of steps. An important aspect was to compare the information obtained with the knowledge and state of construction practice (through the Czech Construction Needs Survey) and with the prediction of its economic and technological development until 2030, or for a longer period of time (see chapter 7.1.).

The evaluation of the fulfilment of the 1st National Roadmap of Build Up Skills (2013) was also a rich source of knowledge, both in terms of the substantive fulfilment of the set objectives and the effectiveness of their implementation (see chapter 6).

The current state and education of individual construction participants and construction professions ensuring the implementation of construction is ensured in the Czech Republic by a number of traditional tools, legislative regulations, practices and a number of organizations are involved in it. Nevertheless, there is no unified system, nor is there a clearly defined responsibility for its implementation, which would allow to provide the necessary preparation for practical implementation of knowledge and skills needed for the implementation of Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings in the construction practice in the Czech Republic in the time and quality required.

This situation is particularly difficult in the preparation and retraining of the persons who carry out and secure the construction. Therefore, the team of authors focused on the following issues:

1) analysis of individual roles, functions on the construction site defining their responsibilities and existing requirements for their training and lifelong learning;
2) analysis of individual construction professions, trades that provide the actual construction, installation of products and technologies in relation to energy-efficient construction;

3) an analysis of the capacity of existing facilities providing basic vocational training and the requirements for its verification and their capacity and readiness to provide new training requirements;

4) analysis of the capacities of existing facilities for holistic vocational training, providing both the updating of professional knowledge and the necessary retraining, the level of their equipment to ensure the new requirements resulting from the implementation of energy-efficient building directives;

5) analysis of the construction market in terms of its size and perspective and the need for human resources to ensure the required transition to new technologies and new products needed for the construction, but also to ensure the operation of energy-efficient buildings.

The authors based this work on their own experience and previous studies. In addition, analytical materials on the development of the construction sector prepared mainly by the Ministry of Industry and Trade were used. The analysis also benefited from available information sources on the Internet, outputs of the Czech Statistical Office, printed materials and interviews with relevant staff of professional associations, chambers and central authorities of the Czech Republic. At the same time, it should be noted that in a number of areas (e.g., secondary and apprenticeship education for the construction sector) the availability of data for a reliable analysis of the above-mentioned issues has **significantly deteriorated** in the Czech Republic. The analysis thus often had to be based on expert estimates, or secondary or indirect sources.

As an example (among many) is the virtual absence of data on renovation rates, which is alarming, especially for the housing stock (where we otherwise have a wide range of information). The commonly quoted rate of renovation of the housing stock of more than 1% per year is therefore only an educated guess.

In the absence of a national data base, the analyses published by CEDEFOP, especially its EU 2020 Labour Force Survey, were all the more welcome.

The work on the analysis itself was conducted in the form of teamwork, in several gradually specifying steps. After the initial definition of the work procedure and the objectives to be achieved, the selection of background material, documents and papers was carried out by the individual authors and the partial sectoral theses were established, after which this material was consolidated in successive steps into the present form of the SQA draft. Emphasis was placed on gaining inspiration for the subsequent work on the new national Roadmap. A significant role was played here by defining the barriers (both material and systemic) to the

successful adaptation of the qualification structure of the construction sector and the education system to the new economic and especially energy and environmental conditions.

The SQA draft was subsequently discussed at two seminars – one on secondary education and its relation to the needs of skilled workers in the construction sector (April 2023), while the other was similarly devoted to higher education. The results of both seminars contributed significantly to the final draft of the SQA currently being presented.

3. National policies and strategies to contribute to the EU's 2030 energy targets in buildings

3.1. A basic strategic framework for energy-efficient buildings

The Czech Republic does not have a separate sectoral strategy for the development of the building sector. However, tasks for the (green) construction sector are contained in a number of other official documents.

The National Energy and Climate Plan of the Czech Republic is the basis for the energy policy of the Czech Republic and the outline for the implementation of the objectives of the Green Deal in the field of energy savings, use of RES and environmental protection. The National Plan of the Czech Republic was developed on the basis of the requirements of Regulation (EU) 2018/1999 of the European Parliament and of the Council on the governance of the Energy Union and climate action.

On 13 January 2020, the document was approved by the Government of the Czech Republic. The document contains objectives and main policies in all five dimensions of the so-called Energy Union. Through this document, Member States are obliged, among other things, to inform the European Commission of their national contribution to the approved European targets in the areas of greenhouse gas emissions, renewable energy sources, energy efficiency and electricity and transmission system interconnectivity[1].

State Energy Policy – on 18 May 2015, the Government of the Czech Republic approved the updated State Energy Policy for the next 25 years. The State Energy Policy identifies five strategic priorities to contribute to the fulfilment of the key objectives. These priorities include: A balanced mix of primary energy sources and sources of electricity production based on their broad portfolio, efficient use of all available domestic energy sources, maintaining the EC's surplus power balance with sufficient reserves and maintaining available strategic reserves of domestic forms of energy; increasing the energy efficiency of the national economy; developing the Czech Republic's network infrastructure in the context of Central European countries, enhancing international cooperation and integration of the electricity and gas markets in the region, including support for the creation of an effective and operational common EU energy policy; support of research, development and innovation to ensure the competitiveness of the Czech energy sector and support of education, with the aim of the need for generational change

[1] https://www.mpo.cz/cz/energetika/strategicke-a-koncepcni-dokumenty/vnitrostatni-plan-ceske-republiky-v-oblasti-energetiky-a-klimatu--252016/

and improving the quality of technical intelligence in the energy sector; and, last but not least, enhancing the energy security and resilience of the Czech Republic and strengthening the ability to ensure the necessary energy supply in cases of cumulative failures, multiple attacks against critical infrastructure and in cases of prolonged fuel supply crises[2].

The Ministry of Industry and Trade evaluates the implementation of the State Energy Policy (SEP) at least once in every 5 years. The aim of the evaluation is to assess the degree of implementation and the validity of the SEP of the Czech Republic on the basis of quantitative and qualitative information. The evaluation is then also the foundation for a possible update of the State Energy Policy. The last update of the SEP was on 12 April 2023, which approved the starting points for updating the new SEP, which is currently being drafted.

The overarching strategic document of environmental protection is the **State Environmental Policy of the Czech Republic 2030** with a view to 2050 (SEP 2030[3]. It addresses the issue of environmental protection in its full scope and sets the strategic direction, i.e. objectives, until 2030. Cross-cutting measures to increase energy efficiency are integrated in this context. Key measures include increasing the energy performance of buildings, achieving energy savings in heating, promoting an increase in the share of high-efficiency combined heat and power and efficient heat supply systems, increasing energy performance and enhancing the share of energy-efficient street lighting.

The climate protection policy in the Czech Republic[4] defines the main objectives and measures in the field of climate protection at the national level to ensure that the targets for reducing greenhouse gas emissions are met in relation to the obligations arising from international agreements (the United Nations Framework Convention on Climate Change and its Kyoto Protocol, the Paris Agreement and obligations arising from EU legislation). This climate protection strategy focuses on the period 2017 to 2030, with a view to 2050, and should thus contribute to the long-term transition to a sustainable low-emission economy in the Czech Republic.

The Climate Change Policy contains a total of 41 measures, ranging from cross-cutting themes and policies, to sectoral measures, research and development, monitoring and actions on international climate protection and development cooperation.

[2] https://www.mpo.cz/assets/dokumenty/52841/60959/636207/priloha006.pdf
[3] https://www.mzp.cz/C1257458002F0DC7/cz/statni_politika_zivotniho_prostredi/$FILE/OPZPUR-statni_politika_zp_2030_s_vyhledem_2050-20220615.pdf
[4] https://www.mzp.cz/cz/politika_ochrany_klimatu_2017

To implement the above strategies, the **Long-term Building Renovation Strategy**[5] to support the renovation of the national stock of residential and non-residential buildings, both public and private, has been developed based on the requirements of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, as amended by Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018.

The strategy includes an assessment of the building stock in the Czech Republic in the residential and non-residential sectors, a methodology for determining energy savings for modelling building renovation scenarios, scenarios of possible development of building stock renovation with indicative milestones for 2030, 2040 and 2050, the choice of a building renovation development scenario to be implemented by the Czech Republic in the following period, an assessment of barriers in the residential, private and public sectors and the Czech Republic's strategy to support the implementation of the optimal scenario. For the practical application of this strategy, see Section 3.6.

3.2. Policies in relation to the implementation of the EPBD and the RES Directives

The EED, RES and EPBD directives aim to increase the energy efficiency of the building stock, which is reflected in increased requirements for the performance of the building envelope, technical systems and the overall technological equipment of the building. Strategic plans with the aim of increasing energy efficiency are also an essential part of this.

The EPBD has been incorporated in Act No 406/2000 Coll. on Energy Management, which amends Act No 3/2020 Coll. and in its implementing regulation, Decree 264/2020 Coll. on the energy performance of buildings. The EED and RES directives are also reflected in Act No 406/2000 Coll. (see below) and in the National Energy and Climate Plan of the Czech Republic.

In the case of the Czech Republic, these are the following laws and decrees:

- Act No. 3/2020 Coll., amending Act No. 406/2000 Coll. on Energy Management,
- Act No. 165/2012 Coll. on Supported Energy Sources and on Amendments to Certain Acts,
- Decree No 264/2020 Coll. on the energy performance of buildings.

Under the EPBD, Member States are obliged to establish energy performance certification for buildings. In the Czech Republic, these are the building energy performance certificates (PENB),

[5] https://www.mpo.cz/assets/cz/energetika/energeticka-ucinnost/strategicke-dokumenty/2020/6/_20_III_dlouhodoba_strategie_renovaci_20200520_schvalene.pdf

which affect both the current owners or tenants of buildings, and future prospective buyers and the overall real estate market. According to Article 9, from 1 January 2019 all new buildings used and owned by public authorities and from 31 December 2020 all new buildings are generally nearly zero energy buildings. When transposed into Czech legislation, this requirement has been tightened in Act 406/2000 on energy management, namely that all new buildings must comply with the nZEB standard as of 1 January 2020.

Act No. 406/2000 Coll. on energy management

The Energy Management Act incorporates relevant European Union regulations, including Directives 2010/31/EU (EPBD) and 2012/27/EU (EED). The Act addresses several points relevant to the construction sector. These are in particular measures to improve energy performance, the development of nZEB, the increased use of renewable and secondary energy sources, the processing of PENB and the labelling of electrical appliances with energy labels. The law also sets out financial systems to promote energy efficiency.

Act No. 3/2020 Coll., amending Act No. 406/2000 Coll., on energy management

Act No 3/2020 Coll. amending Act No 406/2000 Coll, on energy management, clarifies some definitions (nearly-zero energy building, energy audit, energy management, etc.), specifies the method of preparation of the report on the implementation of the territorial energy concept, regulates the conditions and requirements of the State Programme to support energy savings. It also regulates the obligation to visibly display the energy performance certificate of the building in buildings frequently visited by the public, defines more precisely the enterprises that need to conduct an energy audit for their energy management and allows replacing the energy audit with an established and certified energy management system. In addition, the Act regulates the procedure for granting authorizations to energy specialists, the organization and course of their continuous training.

Act No. 225/2017 Coll., amending Act No. 183/2006 Coll., on Act No. 183/2006 Coll., on Spatial planning and Building regulations (Building Act), as amended, and other related acts[6].

The Building Act focuses on three areas, each of which more or less affects building structures. The first area covers the objectives and tasks of spatial planning, conditions for construction, development of the territory and for the preparation of public infrastructure. The second area

[6] This Act is currently suspended and is being amended in the Parliament of the Czech Republic with an as yet unclear outcome.

deals with building regulations, especially the building permits and their alterations. The third area encompasses, for example, design activities and general requirements for construction.

Act No. 165/2012 Coll. on Supported Energy Sources and on Amendments to Some Acts

In terms of relevance to the construction sector, the Act on Supported Energy Sources regulates the promotion of electricity and heat from renewable and secondary energy sources, regulates the financing of the promotion of electricity from supported sources and heat from renewable sources, and ensures the increase of the share of renewable sources in the consumption of primary energy sources to achieve the targets set by the European Union. According to the Energy Performance Directives, the consumption of nZEB, whose standard is mandatory for all buildings since 2020, is to be partially covered by renewable sources.

Decree No. 264/2020 Coll. on the energy performance of buildings

The Decree on Energy Performance of Buildings is an implementing regulation of the Energy Management Act. The Decree incorporates the requirements of the European Directive 2018/844/EU on the energy performance of buildings and establishes the cost-optimal level of energy performance requirements for buildings and the requirements for drawing up an energy performance certificate for buildings. Decree 264/2020 also regulates the requirements for the so-called Nearly Zero Energy Buildings (nZEB).

Decree No 140/2021 on energy audit and Decree No 141/2021 on energy assessment and data recorded in the Energy Consumption Monitoring System

The decrees constitute an implementing regulation to the Energy Management Act and specify the requirements of an energy audit and an energy assessment, which analyse in detail the consumption of a building or a set of buildings. Their execution is obligatory in case the building or a set of buildings reaches a certain level of consumption or in case of applications for subsidy support for energy performance improvement paid from public funds. Decree No. 140/2021 Coll., on energy audits, responds to the change in the existing approach to energy audits, which was enshrined in Act No. 3/2020 Coll., amending Act No. 406/2000 Coll., on energy management, as amended. The change lies in the fact that the procedure of conducting an energy audit is closer to a generally applicable standard, namely the standard ČSN ISO 50002 – "Energy audits – Requirements with guidance for use". The decree now only specifies the requirements for the content of the energy audit report, not the whole process.

New requirements for buildings with nearly zero energy consumption (NZEBs) are set out in the amendment to the Energy Performance Decree No. 264/2020 Coll. The decree introduces unified assessment methodologies and a comprehensive change to the reference building

parameters on which the requirements are based. As of 1 January 2022, the value of **primary energy reduction from non-renewable energy sources** has been changed.

The indicator of primary energy from non-renewable sources decreases by this value, which may lead to the need to supplement the energy concept with the installation of a renewable energy source or the implementation of more efficient technologies or a higher quality building envelope. As of 1 January 2022, the methodology for applying the value in terms of its amount and the classification by building type has changed. The aim of the modification of this value was to define a progressive but construction-technically and economically realistic percentage deduction encouraging the optimization of the building concept.

Table 1: Decreasing the reference value for primary energy from non-renewable sources Δep,R [%]

Specific heating demand of the reference building or zone [kWh/m².a]	Reduction of the non-renewable primary energy reference value $\Delta e_{p,R}$ [%] 1)		
	Residential areas 2)		Other than residential areas
	Building energy reference area ≤ 120 m²	Building energy reference area > 120 m²	
≥ 90	50	60	40
80	45	55	
70	40	50	
60	35	45	
50	30	40	
40	25	30	
≤ 30	20	20	

1) The resulting reduction in the primary non-renewable energy reference value Δep,R for the building as a whole shall be determined in the case of a multi-area building by a weighted average over the energy reference areas of the sub-areas
2) The intermediate values shall be linearly interpolated

Source: Decree No. 264/2020 Coll. on the energy performance of buildings

3.3. Smart building policies

The requirements for "smart buildings" vary depending on the purpose and use of the buildings. However, it is always necessary to meet the criteria of safety, reliability, economical operation and reasonable investment and operating costs. 'Smart buildings' are one element of the broader 'smart city concept.'

In the Czech Republic, many projects have been launched in recent years with the aim of gaining practical knowledge and unifying methodologies for addressing the above mentioned concepts.

In this regard, it is necessary to point out the document titled The National Research and Innovation Strategy for Intelligent Specialization (National RIS3 Strategy), which EU Member States were obliged to prepare in order to identify suitable promising areas of the economy that should be subsequently supported by the European Structural and Investment Funds (ESIF). To this end, the Czech Republic has prepared its National RIS3 Strategy, which reflects the priorities of our economy that should be addressed by the ESIF programmes and selected national R&D support programmes. One of the approved research areas under the National Research and Innovation Strategy is energy savings. The Strategy states that in the field of energy savings it is crucial to develop and demonstrate practically applicable solutions in the end-use sectors – households, industry, services and agriculture. Preparation and demonstration of integral solutions for cities and urban agglomerations (smart cities and regions) in relation to European initiatives, while taking into account the specific features of the Czech Republic, is a complex area.

The idea is to integrate energy generation and transmission, energy use in buildings and energy performance of transport in a synergistic way, all with the application of ICT technologies. In the residential sector, the concept of smart homes and living is to be developed, which is the intersection between construction, local energy production, smart appliances, as well as other elements for a safe and enjoyable life. Energy savings must not only focus on technical solutions, but also on business and financing models. Improving energy performance of buildings, including their insulation, is also essential.

One of the main instruments of support for applied research specifically in the energy sector is the THÉTA programme[7], which is managed by the Technology Agency of the Czech Republic. The programme aims to contribute through outputs, results and impacts from the supported projects to the medium and long-term fulfilment of the vision of transformation and modernization of the energy sector in accordance with the approved strategic materials. This objective will be achieved through support for research, development and innovation in the energy sector, focusing on the following sub-programmes: 1) support for projects of public interest; 2) new technologies and system elements with high potential for rapid application in practice, 3) support for long-term technological perspectives.

The total state budget expenditure for the THÉTA programme for the period 2018-2025 corresponds to CZK 4, 000 million. Non-public resources should correspond to CZK 1, 715 million. The total expenditure therefore corresponds to CZK 5, 715 million. The programme

[7] https://www.tacr.cz/program/program-theta/

allocation is divided into sub-programmes in the following proportions: sub-programme 1 = 15 %, sub-programme 2 = 50 % and sub-programme 3 = 35 %.

3.4. Circular economy policies

The circular economy aims to maintain the value of products, materials and resources for as long as possible in the economic cycle and to return them to the production cycle at the end of their service life, while minimizing the waste generation. The circular economy has become a key concept in a number of European Union policies.

Circular economy at the level of the Czech Republic requires a strategic comprehensive approach. Therefore, in December 2021, the Government approved the Circular Czech Republic 2040 Strategic Framework ("Circular Czechia 2040")[8]. This is the first comprehensive strategy for the circular economy in the Czech Republic. The development of Circular Czechia 2040 reflects the need to promote the principles of the circular economy in the Czech Republic and emphasises the circular economy as a priority for the Czech Republic.

The purpose of the Strategic Framework of the Circular Economy of the Czech Republic 2040 is to formulate the assumptions, objectives and measures for the Czech Republic to be resilient (in the long term) to future environmental threats, including climate change, and to develop an overall sustainable social system through the circular economy. The Czech Republic must be able to respond to future major challenges, including those related to natural disasters or pandemics, etc.

The strategic framework focuses on 10 priority areas: Products and design, Consumption and consumers, Waste management, Industry, Raw materials, Construction, Energy, Bioeconomy and food, Circular cities and infrastructure, Water, Research, development and innovation, Education and knowledge, and Economic instruments.

The goal of the Circular Czech Republic is to achieve a state where the circular economy brings substantial environmental, economic and social benefits to the Czech Republic. Circular Czechia 2040 should enhance the competitiveness and technological advancement of the economy, increase the security of supply of raw materials and resilience to various external shocks, develop an overall sustainable social system, but also create new workplaces.

Circular Czechia 2040 aims to maintain the value of products, materials and resources for as long as possible in the economic cycle and return them to production at the end of their use,

[8] https://www.mzp.cz/C1257458002F0DC7/cz/cirkularni_cesko/$FILE/OODP-Cirkularni_Cesko_2040_web-20220201.pdf

while minimizing the waste generation. The need to strengthen waste prevention permeates the entire Circular Czechia 2040 document, as it is the highest level of the waste management hierarchy and thus an integral part of the circular economy. The strategy seeks to improve the quality of waste management with an emphasis on reuse and recycling, with improvements particularly in the areas of bio-waste, textile, construction, and food waste, packaging and discarded electronics.

The use of secondary raw materials is a priority for industry, the construction sector and the energy industry. As to public procurement, the state will support companies that use products containing secondary raw materials and recyclates. In the area of product and design, companies should introduce new production methods as much as possible using the latest technologies to enable the circular cycle of products. In the case of bioeconomy and food, the aim is to reduce food waste and to improve the efficiency of dealing with bio-waste, e.g. by composting biodegradable waste. In the field of consumption, products should be reused and thus given a 'second' life. The use of disposable products should be reduced. The biggest change to come lies in the behaviour of producers and customers, so that more use is made of materials or products used in the past and customers make informed choices about what to do with these products when they come to the end of their service life. Circular cities and their infrastructure will be supported by modern technologies and the maximum use of secondary raw materials.

In terms of water conservation, Circular Czechia emphasises the maximum possible water saving, especially through sustainable water management and water retention in the landscape. The state will support, among other things, projects for the reuse and recycling of wastewater in industry and research into new technologies for wastewater management. Education, science and research are important aspects of the development of circular economy.

By implementing the set measures, Circular Czechia has long been monitoring, among other things, the following:

- improvements in waste management, including positive impacts on national climate and other environmental targets;
- Improving security of material supply and reducing dependence on material sources imported from outside the EU;
- Increasing the competitiveness of businesses;
- Reducing fossil fuel consumption.

Structural Funds will continue to be used to financially support the development of the circular economy.

3.5. Green public procurement policies

In the Czech Republic, green public procurement can be implemented using the following laws and regulations:

- 134/2016 Coll. Act on Public Procurement;
- Resolution of the Government of the Czech Republic No. 720/2000 on the proposal to support the development of the sale and use of environmentally friendly products;
- Government Decree No. 197/2003 Coll., on the Waste Management Plan of the Czech Republic;
- Act No. 406/2000 Coll., on Energy Management, as amended by Act No. 3/2020 Coll.

The Czech Ministry of Labour and Social Affairs ("MoLSA") has been committed to the concept of responsible public procurement since 2014. The MoLSA has defined two strategic objectives in this area:

- implementation of strategic public procurement within the Ministry of Labour and Social Affairs;
- supporting the implementation and development of strategic public procurement in the Czech Republic.

Key activities to support the latter strategic objective have been implemented since 2016 under the project Supporting the implementation and development of socially responsible public procurement.

The project has created a long-term consulting and expert platform for the development of this concept and offers, among other things:

- advice and consultation on the use of RPP (defining suitable opportunities within the framework of public procurement, definition of specific requirements or criteria and their contractual procedures, incorporation of RPP principles into internal regulations, support in the implementation of RPP within the organization, etc.);
- a platform for obtaining information, good practice examples, model texts, answers to questions, etc. (web);
- activities to support the exchange of experience and the gathering of information (strategic purchasing schools, workshops on sub-topics, tailor-made trainings for contracting authorities, cross-cutting trainings, e-learning, international conferences).

A strategic approach to public procurement has already been developed in the Czech Republic by a number of contracting authorities who apply responsible public procurement in their practice. In doing so, they not only procure the necessary goods, services and construction works, but also take into account the related social, environmental and wider economic

aspects. Based on our existing experience, we have selected key steps and recommend the process described in the Methodology – Implementing Responsible Procurement in an Organization[9].

3.6. Predicted contribution of the construction sector to the 2030 targets

As part of the National Energy and Climate Plan, scenarios for setting building renovation milestones by 2050 have been proposed, based on an analysis of the current state of the building stock, building renovation policy and its effect on increasing the energy performance of the Czech building stock.

The current development of building stock renovation (BAU scenario) reflects the current situation on the market. The modelling of this scenario is based on data available from the Czech Statistical Office and the Ministry of Industry and Trade. It is a scenario that takes into account the effect of the state's policy on increasing the energy performance of buildings.

The BAU scenario is based on the already implemented measures that contributed to the renovation of the building stock in the period 2014-2020 and to the assumption that the set renovation rate and depth of renovation, including other input factors, will continue in line with the current trend.

The set values for the renovation rate, final energy consumption and renovation "depth" determine the setting of the Real Scenario, assuming greater government intervention by 2030 and targeting fiscal and legislative measures to shift the renovation "depth".

Based on data from the National Energy and Climate Plan, the following developments in the building stock renovation up to 2030 can be assumed in a simplified way, taking into account the contribution of the building sector in achieving the 2030 climate and energy targets:

Table 2: Final energy consumption savings in a given year and cumulative investment costs

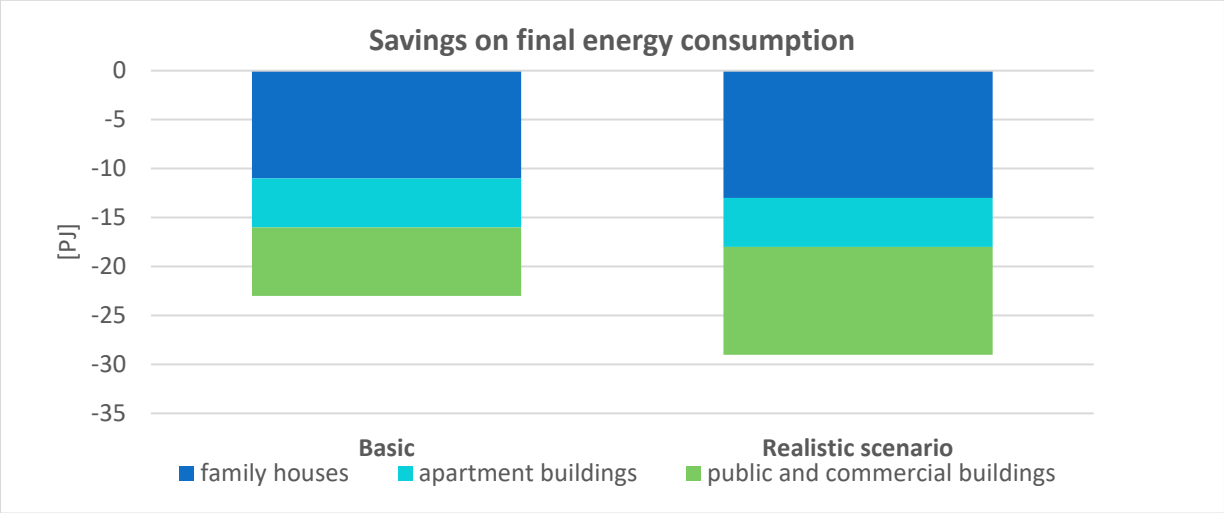
For the period 2021-2030	Basic	Realistic scenario
Savings in final energy consumption over the period [PJ]	-23	-29
Family houses	*-11*	*-13*
Apartment buildings	*-5*	*-5*
Public and commercial buildings	*-7*	*-11*

[9] https://sovz.cz/wp-content/uploads/2019/06/sovz_metodika_implementace_web.pdf

Cumulative investment costs [CZK billion]	*218*	*262*
Family houses	*113*	*120*
Apartment buildings	*30*	*33*
Public and commercial buildings	*75*	*109*

Source: MIT for the purposes of the National plan

Figure 1: Final energy consumption savings for the period 2021-2030 (in PJ)



Source: the MIT for the purposes of the National Plan

3.7. Digitalization and BIM in construction.

Digitalization in the construction industry has so far been slower than in other industries, but it has brought significant changes in the past decade. These can be documented in the range of activities that constitute the construction process, including a change in the proportion of work required for each stage and phase, and thus a change in the requirements for new professions, or a **substantial change in the knowledge and skill requirements for the preparation and execution of construction**, or in the division of responsibilities for individual tasks. Although these changes are already noticeable in practice, quantifying them in the future is very difficult. For both the construction industry and educational institutions, this implies one basic (systemic) requirement: readiness for flexibility.

General changes in digitalization: overall preparedness of about 15% of companies that embrace it. 30% of companies see it as a positive; higher training and qualification requirements and perhaps savings (time, material, waste-related labour) is often a barrier.

Digitalization in the construction industry is mostly associated with the application of the BIM method throughout the construction process. However, a practical obstacle is the lack of

continuity between these processes and the various 'gains' from the use of digitalization within each process:

- digitalization/digitization has significantly progressed in project practice. Digital documentation, however, with exceptions, is not usable in state approval processes (it has to be converted into the classic "paper form" for the time being). The processing of a BIM model that can also be used by other partners like manufacturers of construction products and construction contractors is, however, very demanding and it has not been resolved who will pay for this work.
- Digitalization in the production of construction products (automation and robotization of production: bricks, prefabricated products, windows and glass, plastering and others) has advanced significantly, is comparable to Industry 4.0 processes, and offers "digital documentation" for project practice. However, the scope and structure of the data required for automated and robotic manufacturing is very different and its pass-on in practice is still very low.
- Digitalization for building contractors, if well designed, allows to rectify clashes between various professions in advance on the model, to perform virtually online inspection of construction works and evaluation of findings in the construction diary. In addition, digitalization enables material savings and shortening individual processes. The use of digital models is also a prerequisite for the deployment of robots and self-driving construction equipment. So far, it has only been used in limited quantities for some of the major civil engineering and transport projects.
- Digitalization and BIM models in facility management, which is also a prerequisite for effective energy efficiency management systems for buildings, is still in its early stages.

The state BIM concept is based on the Government Resolution No. 41 of 18 January 2021 on the amendment of the Government Resolution No. 682 of 25 September 2017 on the Concept of the Implementation of the BIM Method (Building Information Modelling) in the Czech Republic, upon the performance evaluation of the Concept of the Implementation of the BIM Method for the time period from September 2018 to June 2020. The implementation of the BIM concept continues for the sixth year and is based on 38 measures. The MIT is the gestor of this concept while the implementation has been entrusted to ČAS (Czech Agency for Standardization).

The underlying vision of this concept is "To achieve a more efficient construction industry through standardization and methodological support in the field of digitalization/digitization." The work on the Digital Technical Map has started, which will become the basis for further building of the digital model of the territory. The sub-objectives of the concept are:

- Transparency and communication between construction partners;
- Contractual standard for construction projects;
- Pilot projects (e.g., State transport infrastructure fund);
- DSS data standard (data standard architecture);
- Products harmonized by the EU Construction Products Regulation (CPR) and Czech technical standard ČSN;
- Building valuation;
- Basic and lifelong education;
- Standards and terminology.

3.8. Establishing a legal framework for the further development of digitalization

The current Building Act No. 183/2006 Coll., on spatial planning and building regulations, valid until 30 June 2023, has opened up space for the preparation of digitalization through a series of updates. In accordance with this law, a **project for the digitization of construction and spatial planning procedures** has been launched, aiming to build a live digital system that will facilitate the process for all participants in the construction procedure, as there will no longer be a need to travel around the offices, but everything will be handled from the comfort of home. So far, the project has not been reflected in official and construction practices.

Although the new Building Act 283/2021 Coll. has come into force, its amendment is currently being completed. Some of the many modifications discussed include a more relaxed regime for more types of energy buildings, greener public infrastructure, etc.

The Spatial Development Policy of the Czech Republic is a nationwide spatial planning instrument, which serves mainly for the coordination of spatial development at the national level and for the coordination of spatial planning activities, especially of regions, and at the same time as a source of important arguments in the promotion of the interests of the Czech Republic within the framework of the spatial development of the European Union. The drafter is UUR - Institute of Spatial Development Brno. The draft update is from January 2023.

Policy of Architecture and Building Culture of the Czech Republic. At its meeting held on 4 January 2023, the Government approved the material Policy of Architecture and Building Culture of the Czech Republic – Update 2022 by Resolution No. 6. The updated policy replaces the original document approved in 2015. The Policy of Architecture and Building Culture of the Czech Republic (PASK ČR) is a non-legislative strategic document with national scope. It sets out a vision and basic objectives in the medium and long-term horizon that should lead to an increase in the quality of the built environment. In order to achieve them, it identifies several dozen measures, which have a specific guarantor and a deadline for fulfilment.

3.9. Education policy in the construction sector

The main objective of shaping the educational structure at the national level must be to find a form capable of responding flexibly to the demands of the labour market. The task of the state authorities is to forecast developments, in coordination with employers' unions and professional associations. The current **Concept for the Development of Education** in the Czech Republic sets high parameters – the target is 86 % of the population with upper secondary and university education. The current number of people who achieved the Certificate of Secondary Education (*maturita* in Czech) or higher level education is 67%. It is not quite clear on what assumptions the approach to this ambitious project was chosen and to what extent the natural composition of the population in terms of intellectual abilities, learning aptitudes and graduate employability was taken into account.

In practice, the implementation of the objectives of the Concept is based on the following legislative sources:

- Act No. 179/2006 Coll. on Verification and Recognition of the Results of Further Education results and on Amendments to some other Acts (Act on the Recognition of Further Education Results);
- The National Qualifications System [10], an information portal about the system of nationally recognized professional qualifications in the Czech Republic;
- National system of occupations [11], an open database of occupations, which is managed by the Ministry of Labour and Social Affairs of the Czech Republic.

[10] https://narodnikvalifikace.cz
[11] https://www.nsp.cz

4. Key data on construction and energy

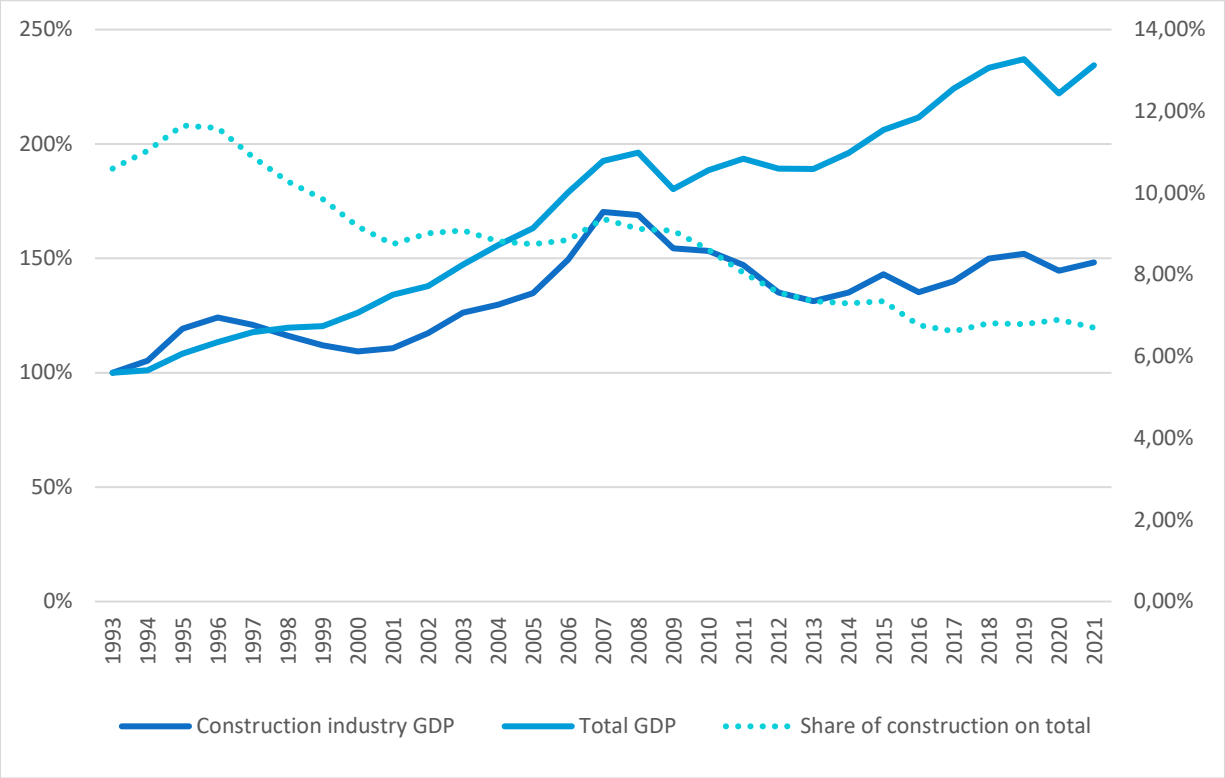
4.1. Overall performance of the construction sector

In 2022, according to national accounts, the annual growth rate of construction accelerated to 15.65% (at current prices). After a slight decline in 2020, gross value added in construction sector reached growth values in 2021 and achieved an even faster growth rate in 2022, growing by 11.5%. The share of the construction industry in the gross added value of the entire economy in 2022 reached 5.63%. This value practically coincides with the EU average (27 countries).

However, gross value added in constant 2015 prices in the construction sector continued to decline in 2021, well below the level of 2018. In fact, it has declined every year since then, most notably in 2020. In this respect, the construction sector has confirmed its characteristic of high sensitivity to economic and socio-political developments: over the 15 years between 2007 and 2021 (inclusive), 7 years of year-on-year decline, 7 years of growth and 1 year of stagnation were recorded.

The structural problem of lack of capacities in the construction sector is well illustrated by its macroeconomic position. Between 2011 and 2013, the construction sector suffered a deep crisis. In a delayed response to the shock of the so-called Great Recession of 2009, the construction sector declined by 10% between 2011 and 2013. The plunge in the construction sector was relatively larger than that of the economy as a whole and, unlike the overall performance, the sector failed to return to the performance of the boom peak in 2007 and 2008. **As a result, the capacity of the construction sector has been irreversibly reduced**. A number of workers and firms have left the sector and have not returned, and its capital position has similarly weakened.

Figure 2: GDP of the economy and construction sector in constant prices 2015, year 2008 = 100%



Source: CZSO, National Accounts Database, GDP Production Method, available at: https://apl.czso.cz/pll/rocenka/rocenkavyber.makroek_prod

Main construction works (according to the supply contracts) express the total value of its own construction activities performed by the reporting unit on the basis of a supply contract for the end user (the builder), including the value of any subcontracting of construction work[12]. In 2021, companies carried out construction works worth CZK 580 billion, representing a year-on-year growth by 8.3% (in current prices). After 2021, when the construction sector was adversely affected by the coronavirus pandemic, construction companies are finding it difficult to return

[12] The indicator is statistically monitored in the CZ-CPA commodity classification and differs from the sales of services as these are classified according to the predominant economic CZ-NACE activity. Companies classified in section F of the construction sector according to CZNACE include in their services also activities that fall outside construction work, e.g., developer activities, transport, etc. In contrast, main construction works according to the CZ-CPA commodity breakdown is monitored for all enterprises, i.e., also for enterprises classified in CZ-NACE other than construction, e.g., agricultural enterprises have construction production, but the predominant economic activity is agriculture. The values of sales of services and main construction works cannot coincide given the above. Both sets (sales of services CZ-NACE F and main construction works CZ-CPA construction manufacturing) are for enterprises with 0 employees and more.

to a normal course, as they have been hampered in particular by a sharp rise in prices – on average, construction prices rose by 5.1% in 2021. In 2022, companies carried out construction work worth CZK 681.9 billion, which represents year-on-year growth of 17.4% (in current prices). Construction work in the country was higher year-on-year in all categories. Work on new construction grew faster and within the work on the construction of non-residential production buildings and then on residential buildings grew the fastest. At the same time, there was again a sharp increase in prices in the entire industry - specifically by 12.4%.

Civil engineering construction accounted for roughly one third of domestic new construction and was up by 3.2% year-on-year in 2022, where for building construction, it was a growth of 2.3%. **Approximately one-quarter of the construction work in the long term is on repair and maintenance**. The share of repair and maintenance was highest in 2016 (28.8% of domestic construction work) and has declined since then (to a 23.1% in 2021 and 21.5% in 2022), which is definitely not a favourable trend in a situation where renovation is to become a dynamic direction in the development of the construction industry.

Table 3: Domestic main construction works in current prices (CZK million)

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Residential buildings	43 690	46 344	51 603	57 574	59 791	73 689	78 971	73 835	100 662
Non-residential non-manufacturing buildings	55 079	59 811	56 185	42 645	48 462	73 143	78 006	74 586	73 000
Non-residential manufacturing buildings	58 630	60 615	62 155	71 171	88 662	88 428	91 860	76 139	88 180
Civil engineering buildings	119 423	130 563	151 693	117 927	114 584	123 517	145 921	166 219	170 097
Water management buildings	6 928	5 242	4 704	2 980	2 937	3 881	4 810	4 466	4 274
Repairs and maintenance	103 838	114 438	119 764	118 422	123 105	124 867	125 315	127 919	131 004
Domestic total	387 588	417 013	446 104	410 719	437 542	487 526	524 883	523 164	567 217

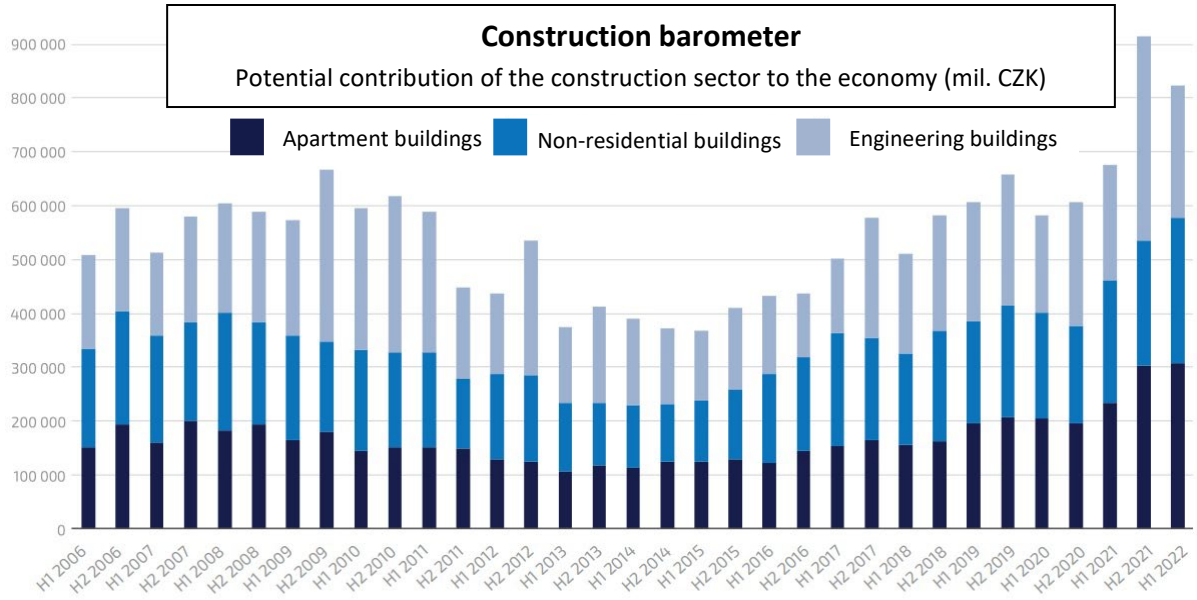
Source: CSO data

4.2. Current state and prediction of the construction market

The construction works permitted in the second half of 2022 have the potential to bring more than CZK 823 billion to the Czech economy. Compared to the previous half-year with a possible contribution of CZK 916 billion, this is a roughly 10% decrease. The "driving force" of the construction sector is now becoming residential construction. In the previous period, the largest potential contribution to the economy was – as mentioned – civil engineering.

The decline in value compared to the second half of 2021 is mainly due to a decline in the value of building permits for civil engineering constructions. This has fallen by 35% compared to the record value in the second half of 2021, mainly due to transport construction, where the value of building permits fell by more than half compared to the previous half-year (-53.5%). Even so, the estimated total contribution of civil engineering is still above the average of previous years.

Figure 3: Construction Barometer



The supply of new housing has started to rise again slightly due to faster permitting and a fall in demand but is still well below the level it was at just a few years ago and far below the level that could satisfy the long-term high demand and, moreover, wipe out the housing deficit created in previous years.

Demand for new housing in the first half of the year was very negatively affected by the uncertainty about the impact of the war in Ukraine and also by the rocketing prices of mortgages together with the reintroduction of credit limits by the CNB, which are also binding for banks as of April 2022. Most people are currently putting off taking out a mortgage and waiting for a time when interest rates drop again. In Prague, around 2,000 new flats were sold in the first half of the year (2,700 in the previous half-year), while in the regions 3,100 new flats were sold (3,900 in the previous half-year). Prices of new flats continued to rise, but at a much slower pace. In Prague, prices rose by around 5% in the first half of the year (but still by around 20% year-on-year). However, the situation is different for rents, which in some cities increased by more than 20% year-on-year and the rate of growth is gradually accelerating.

On the other hand, the construction of modern warehouse areas continues at a record pace. In the first half of 2022, 452,000 m² of warehouse areas were delivered to the market, and roughly twice as much is expected to be completed by the end of this year. Almost half of all new warehouse projects under construction are located in the vicinity of Olomouc, Plzeň and in the Moravian-Silesian region. Despite the massive boom in warehouse construction, demand remains unfulfilled and therefore rents are rising dramatically.

The civil engineering sector is experiencing a significant decline. Construction companies are usually able to pass on at least part of the increased costs to the client, but for public engineering contracts the price is usually fixed by a public tender. In such a case, it is more profitable for some construction companies to withdraw from the contract despite the penalties, as the implementation could be fatal for them.

4.3. Construction market – public and private procurement

Construction work in the country was higher year-on-year in all categories in 2022. Work on new construction grew by 20.6%, work on repairs and maintenance by 9.7%. Traditionally, the largest share of new construction is occupied by engineering structures, which play an irreplaceable role and thus significantly influence the development of the construction industry, in which a total of CZK 199.0 billion was invested in 2022. This means an increase of 17.0% in a year-on-year comparison. In 2022, the share of engineering structures of new construction decreased slightly to 37.8%, while the highest share of engineering structures in new construction was 49.4% in 2010.

The second group with a significant share of new construction works is residential construction, which maintained its share of new construction at 23.6%, which is its highest share since 2000. In 2022, residential construction increased by 23.4% year-on-year to CZK 124.2 billion. Its development was influenced by the high prices of construction works and also high demand. Significant growth was achieved by the construction of non-residential production buildings. In a year-on-year comparison, they were higher by more than a third (by 34.8%) with an investment of CZK 118.9 billion. Non-residential manufacturing buildings accounted for more than a fifth of new construction. This group of buildings accounted for the largest share of new construction at the beginning of this century and accounted for roughly a third of new construction (33.7% in 2001). Construction work on non-residential non-production buildings, i.e. medical, school, administrative, cultural buildings, hotels, etc., reached CZK 79.1 billion with a year-on-year increase of 8.4%. Work on these buildings has been declining for the last four years. The smallest group of new construction is represented by water management structures, in which a total of CZK 4.6 billion was invested in 2022. Another key and permanent item is construction work on repairs and maintenance, which in 2022 reached CZK 143.7 billion. In a

year-on-year comparison, they increased by 9.7%. Repairs and maintenance usually accounted for a quarter of domestic construction, but in 2022 their share fell to 21.5%, which was the lowest share of domestic construction since 2000.

A different view of the structure of contracts in the construction industry is provided by the classification by type of contracting authority. Around 80% of the production of the construction industry is carried out in the non-financial business sector. These are mainly development projects of commercial and administrative centres, construction of transport networks and housing complexes of civil engineering and building construction. The remaining 20 % of production is carried out by households, consisting mainly of new construction of family houses and apartment buildings and their renovation and modernization.

Table 4: Construction contracts for the period 2019–2021

	2019		2020		2021	
Category of construction works	Number of public contracts awarded	Final price in millions CZK without VAT	Number of public contracts awarded	Final price in millions CZK without VAT	Number of public contracts awarded	Final price in millions CZK without VAT
Building construction and renovation	697	16,662	1,441	75,882	566	18,639
Linear and civil engineering constructions	1,325	101,280	327	7,958	1,292	110,312
Ancillary construction works	398	10,332	690	16,627	134	4,360
Other	1,463	39,211	1,950	52,390	2,608	84,048
Total construction works	3,883	167,486	4,408	152,858	4,600	217,361

Source: Ministry of regional development Note: The data on prices are registered without VAT, the commodity categories have been processed according to the lists of the corresponding CPV codes prepared for the Ministry of Regional Development by the NIPEZ Codebook operator.

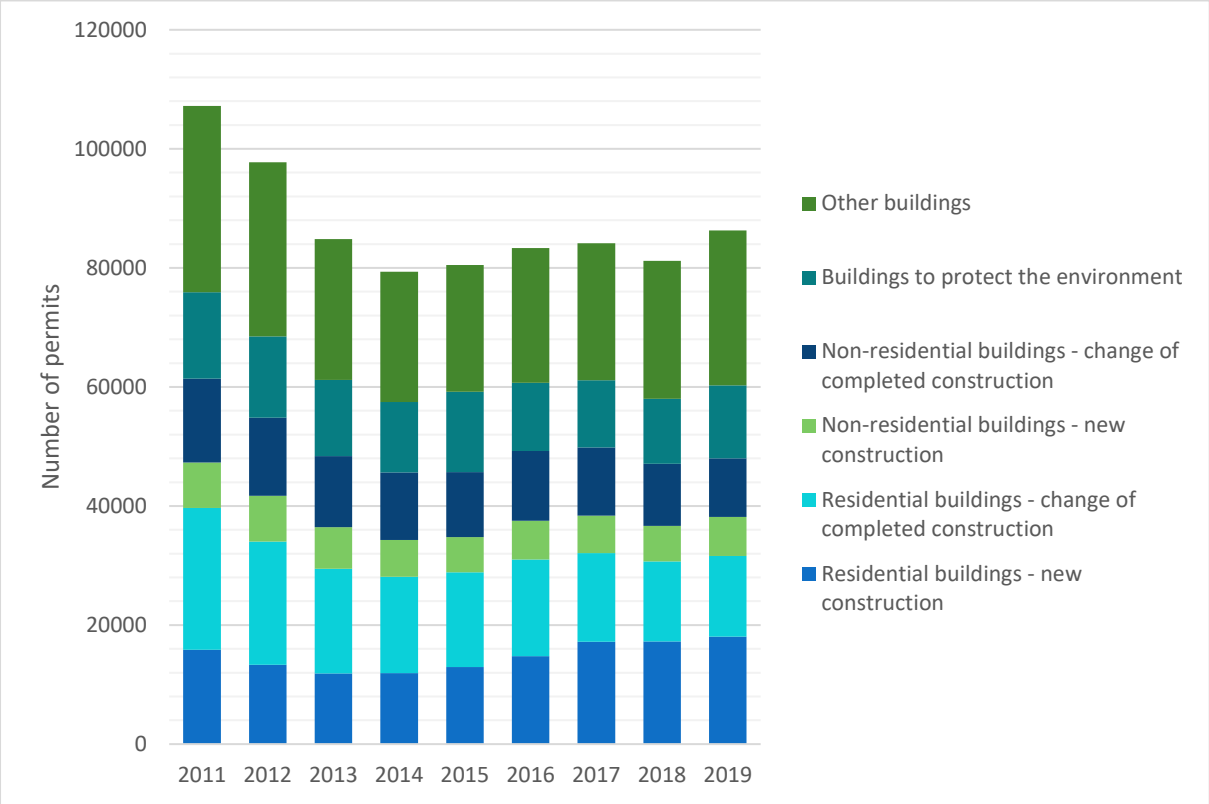
4.4. Building permit

The number of building permits issued turned to growth in 2021, with 5.8% more permits issued year-on-year, with a total of 90 962 building permits. In 2022, on the contrary, there was a decrease in the number of building permits, when 86 049 were issued. The decrease in the number of permitted buildings affected all types of buildings, i.e. residential, non-residential, as well as permits for traffic engineering constructions.

The trend in the number of permits has been volatile in recent years, with a decline in 2018 and 2020. For comparison, in 2011 the building authorities issued 107 231 building permits, but the

indicative value of a building per building permit at that time was 40% lower than today. The value for all issued building permits in 2021 amounted to CZK 521.4 billion, which means an increase of about one third in the year-on-year comparison. The significant increase in the indicative value of buildings was caused mainly by rising prices and also by increasing residential construction. In addition to the continuing problem of labour shortages, shortages of materials and equipment have become increasingly evident, reinforcing price pressures throughout the sector. New construction and changes to completed buildings, both in residential and non-residential construction, have seen an increase in building permits. Non-residential construction achieved faster year-on-year growth, particularly in new construction, which was up 17% year-on-year, and for the second year running, permits for new non-residential construction grew at a double-digit rate. In residential construction, both new construction and change in completed buildings increased at a rate of about 7%. In 2022, however, the indicative value of building permits decreased to CZK 515.1 billion.

Figure 4: Comparison of the number of building permits for each type of construction



Source: SEVEn, based on data from Czech Statistical Office

The graph above shows the overall development of building permits over time. Building construction accounts for an average of 57% (the average for 2011 to 2019) of all building permits, with residential buildings accounting for approximately 36% of all building permits.

4.5. Development of prices for construction works

After a significant rise in construction prices in the early 1990s (following a general price increase that sought to remove price disparities from the previous period of a centrally controlled economy), the trend of price increases remained, but the annual rate of increase gradually declined. Between 2003 and 2006, the growth rate was stable at around 3%, rising to 4.1% in 2007, 4.5% in 2008, before falling to 1.2% in 2009 and turning negative at 0.1% in 2009, with similar (marginal) negative 'growth' in 2010 and 2013. The following table shows the development of construction prices in the following years. Unfortunately, the year-on-year price growth of more than 5% observed in 2021 cannot be seen as a fluctuation similar to those that occurred in the past, but as a precursor to even faster price growth, experienced in 2022, when it is according to the preliminary estimate of the CSO about 12.4%.

Table 5: Price indices of construction works by CZ-CC classification (same period of the previous year = 100)

Code CZ-CC	Title	2013	2014	2015	2016	2017	2018	2019	2020	2021
	Construction works	98.9	100.5	101.2	101.1	101.7	103.2	104.6	103.6	105.1
1	Buildings	99.0	100.5	101.1	101.1	101.8	103.3	104.6	103.5	105.7
11	Residential buildings	98.9	100.4	101.1	101.1	101.8	103.5	104.6	103.4	105.7
12	Non-residential buildings	99.0	100.6	101.1	101.2	101.8	103.3	104.6	103.5	105.8
2	Engineering works	98.8	100.4	101.4	101.1	101.5	103.1	104.7	103.7	104.4
21	Transport works	98.8	100.5	101.4	101.2	101.3	102.9	104.5	103.6	104.1
22	Pipe lines	99.0	100.4	101.2	100.9	101.8	103.3	104.7	103.8	104.9
24	Other engineering works	98.5	100.3	101.6	101.4	102.0	104.3	105.8	104.7	105.4

Source: CSO, based on the CZ-CC classification

4.6. Employment and wages

According to national accounts data, employment in the construction sector peaked in 2010, when the construction sector employed the highest number of people (505 thousand). In the following years, employment declined and since 2015, employment in the sector has oscillated

around 400 thousand persons, including entrepreneurs, with minor fluctuations. In 2022, employment slightly decreased to **417 thousand people** compared to the previous year.

Table. 6: Trend in employment in the national economy and construction

	1993	1998	2003	2008	2013	2018	2019	2020	2021
Total	4,873.5	4,865.7	4,733.2	5,002.5	4,937.1	5,293.8	5,303.1	5,234.9	5,213.4
Construction sector	441.2	491.1	458.3	480.8	420.3	384.0	376.9	395.4	413.4
Craftsmen and repairers	1,098.2	1,012.5	927.5	951.7	851.0	864.8	849.4	835.8	797.7
Machine and plant operators, fitters	720.8	676.8	666.6	704.6	641.7	727.0	728.4	703.5	693.1
Support and unskilled workers	390.5	332.8	293.3	283.7	274.8	287.1	323.4	316.7	293.8

The above table shows that while total employment in the national economy has grown by about 10% over the past 30 years, the trend in the construction sector has been exactly the opposite, with a loss of one tenth of the workforce. Surely this has to do with the general decline (both absolute and relative) in the employment categories 'craftsmen', 'machine operators' and 'support workers.'

Employment data from the national accounts also include people working through employment agencies. In addition, unregistered or undeclared workers account for a significant proportion. The number of such persons was estimated at 44,000 in the construction sector, representing 10.9% of the total number of employed persons in the construction sector. The declining number of unemployed in recent years has also led to a decline in the number of undeclared workers in this sector. The share of foreign workers employed legally or illegally in the construction sector can currently be estimated at about 21%, with 74 thousand Ukrainian citizens officially employed at the end of 2021 alone.

The problem of a shortage of workers in lower-skilled construction positions is being addressed by employing foreigners. It is a fact that foreigners (within the meaning of the Employment Act, these are mostly non-EU citizens) work for lower labour costs, which correspond to their lower qualifications. There is basically no interest in the work that these employees do among unemployed Czech citizens.

The one-off (often illusory) economic effect of employing foreigners can be very risky. The employment of foreigners is associated with the risk of illegal work, where persons without work permits and residence permits work in the Czech Republic. Illegal employment is then often in the hands of illegal structures within the so-called client system and the whole system poses a direct threat to entrepreneurs. However, the Czech construction industry cannot

currently do without the work of foreigners, especially in less skilled professions. This is also recorded in development data of 2022, when the number of workers in the construction industry increased by 17 000 year-on-year, precisely thanks to the employment of citizens of Ukraine (it is not certain to what extent these were newly coming workers or workers which had been working illegally and changing their status).

The share of people employed in the construction sector (from national accounts) in total employment in the Czech Republic decreased to 7.53% in 2021, and practically became comparable to the similar share in the EU (27 countries). This is a significant change compared to the situation 10 years ago, when the share in the Czech Republic considerably exceeded the share in the EU. This is a consequence of the trend of increasing employment in the construction sector in the EU countries, accompanied by a trend of decreasing (or stagnating) employment in the Czech Republic.

The Czech construction industry is characterised by a traditionally low share of employees – about 60% (compared to other economic sectors with more than 80% of employees) and a very high share of small firms (sole traders). Another specific feature is the high share of employment in the smallest enterprises in the total employment in the sector. In 2021, enterprises with 0-19 employees accounted for 67% of those working in the construction sector, while enterprises with more than 250 employees accounted for only 9%.

Although wages in the sector increased slightly, with the average gross monthly nominal wage of construction workers rising by 2.1% year-on-year to CZK 32 112 in 2021, the construction sector was one of the sectors with the lowest wages. On average, the average wage for the whole country for all sectors reached CZK 37 903, with a roughly 5% year-on-year growth. By comparison, in 2010 the nominal monthly wage in the construction sector was CZK 26 312, slightly above the average wage for the whole national economy at that time. In 2022, the gap between the average wage in the construction industry and the average in the national economy has widened even more. However, it cannot be ruled out that part of the difference was and is compensated by income from the grey zone.

One of the reasons for the deteriorating wage ratio in the construction sector is the high number of small construction firms with up to 20 employees and medium-sized firms with up to 500 employees, working under lower cost and wage conditions than large firms.

The relative deteriorating of wage conditions in the sector is generally not contributing to the attractiveness of employment in the construction sector. On the other hand, however, wage inequality is increasing, where on the one hand companies are able and willing to pay very well for skilled workers, be it on the construction site or in management, and on the other hand, it is the remuneration of unskilled workers that is decreasing the average.

As for a more detailed qualification structure of employment in the construction sector, national statistics does not provide the necessary data, but the results of the "EU 2020 Labour Force Survey", implemented by the CEDEFOP agency, can be used. It shows that in 2020 there were 402.2 thousand workers in the Czech construction industry, of which 15.3% were in Hi-tech professions and the share of people with university education was 11.4%, of which a large part were certainly people with technically oriented education. In total, the absolute number of such persons can be estimated at around 40,000. Similarly, the average annual loss of these workers (retirement or moving to other fields) can be estimated at about 2.5 thousand people – an interesting figure in correlation with the capacity of construction-oriented universities in the Czech Republic (see 5.2).

In terms of the detailed structure of employment in the construction sector, other data from the analysis cited above are also noteworthy. It indicates that out of **402.2 thousand workers**, 186.7 thousand were construction workers, 30.6 thousand were assemblers and 30.2 thousand were drivers and operators. In total, therefore, **247.5 thousand people** can be classified as executive workers directly related to construction production on building sites. "In opposition" to them stood **154.7 thousand workers** who were in one way, or another engaged in management! This means that there are current**ly about 0.6 management workers per one executive worker in the country**. There is no doubt that even behind this figure there are large reserves for labour productivity growth in the upcoming period.

4.6.1. Employment structure

As for the more detailed qualification structure of employment in the construction industry, the national statistics unfortunately do not provide the necessary data. Statistics on the current number of professionals in the Czech construction sector according to specific professions or EQF are completely missing.

The authors here made an estimate based on the "EU Labor Force Survey 2020", implemented by the CEDEFOP agency. It shows that in 2020, 402.2 thousand workers worked in the Czech construction industry, of which 15.3% were related to Hi-tech professions. The share of people with university degree was 11.4%, a large part of which will undoubtedly belong to persons with a technically oriented education. In total, the absolute number of these people can be estimated at about 40 thousand. The average annual loss of these workers (retirements or shifting to other fields) can be estimated at about 2.5 thousand people - which is an interesting figure in correlation with the capacities of construction-oriented universities in the Czech Republic (see chapter 5.2.).

From the point of view of a more detailed structure of employment in the construction industry, there are other interesting data from the cited analysis. It assumes that out of **402.2 thousand**

workers, 186.7 thousand were construction workers, 30.6 thousand were drivers and 30.2 thousand operators. In total, there are **247.5 thousand people** classified as executive workers directly related to construction production on construction sites. Interestingly, the data estimate **154.7** thousand workers involved in management. This means that **for one executive worker in the construction industry in the Czech Republic, there are currently approximately 0.6 managers**. There is no need to doubt that there are large reserves for the growth of labor productivity in the next period.

4.7. Number and structure of construction companies

At the end of 2022, construction companies (CZ - NACE Section F Construction, 41-43) accounted for 14.02% of the total number of registered entities in all sectors, i.e. 351, 930 entities. Out of the total number of registered construction companies, about 92% were private entrepreneurs (individuals) and 8% were commercial companies. The following table shows the evolution of the number of economic entities in the construction sector. As can be seen, these numbers have been relatively stable over the long term, with significant growth only occurring in recent years – this may be a response to the conditions resulting from the Covid-19 pandemic.

Table 7: Economic entities by predominant CZ-NACE activity

Year	2010	2011	2012	2013	2014	2015	2016
Number	322,309	327,356	329,133	310,856	314,707	317,428	320,543
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
Number	326,278	330,521	335,443	340,410	345,959	351,930	

The number of entities in the construction sector in 2021 increased only slightly compared to the previous year and reached a total of 187.5 thousand enterprises. Traditionally, the largest number of enterprises falls into the category of the smallest enterprises with up to 19 employees.

Table 8: Business entities by field of activity

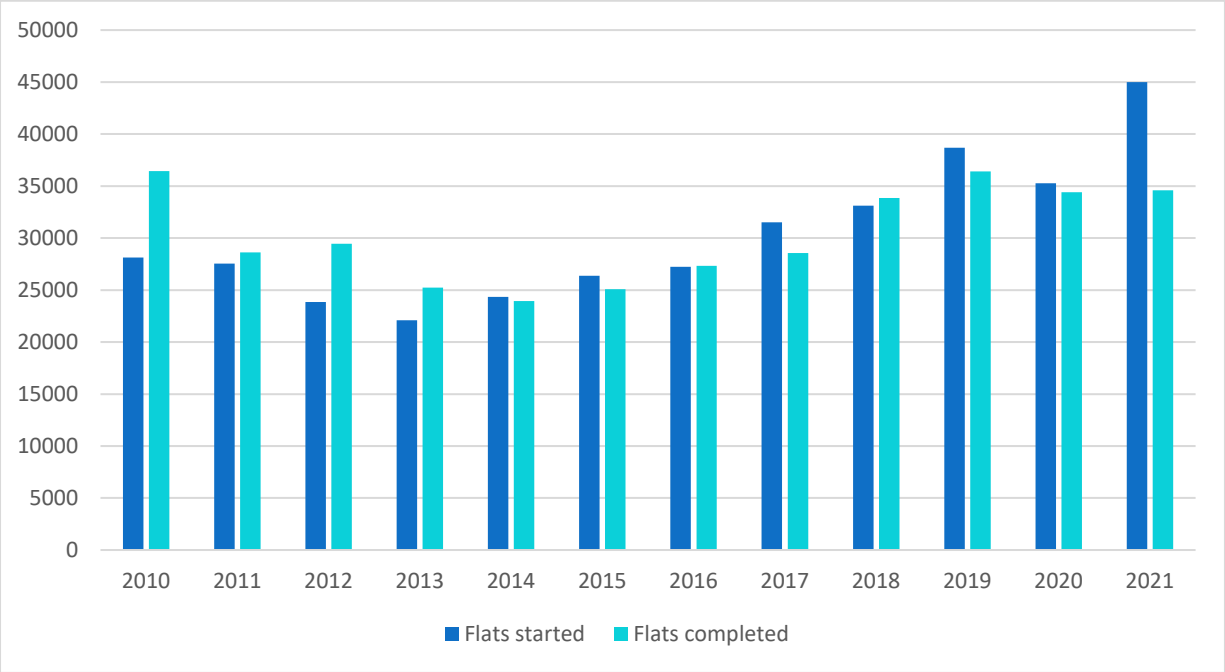
	2013	2014	2015	2016	2017	2018	2019	2020	2021
41 Building construction	32,331	32,433	32,254	30,530	30,762	31,238	31,261	31,208	30,979
42 Civil engineering	2,221	2,101	1,980	1,759	1,725	1,674	1,690	1,677	1,673

43 Specialized construction activities	135,942	136,272	138,245	143,540	144,903	148,735	150,681	152,820	154,825

4.8. Housing construction

Housing construction is one of the most important and best documented segments of the civil engineering sector and is also an essential identifier of the standard of living of the population. However, as the chart below shows, housing construction is marked by considerable fluctuations over time.

Figure 4: Comparison of the number of flats started and completed between 2011 and 2021



Source: SEVEn, based on data from the CSO

Between 2011 and 2021, the number of housing starts and completions increased by almost 38% and 17% respectively.

In terms of the current development of housing construction, the high demand for housing has had a positive impact, with the number of housing starts returning to significant growth in 2021 after a decline in 2020. The low comparative base in 2020, marked by the situation related to Covid-19, also contributed to the year-on-year favourable development. The number of housing completions in 2021 stagnated at the level of the previous year. In 2021, construction companies started 44,992 flats, the highest number of starts since 1998, and an increase of 27.6% year-on-year.

Within the housing construction group, growth was recorded in almost all categories of housing construction, with only the renovation of apartment buildings lagging behind. The main bulk of the growth in housing starts in 2021 was in new apartment buildings, with a total of 17,098 starts, an 81.4% year-on-year increase. The significant increase in apartment buildings was influenced by the low comparative base, however, the highest number of apartment buildings commenced since 1998, indicating that construction of apartment buildings was thriving. As a result, their share of the total number of housing starts increased to a significant 38%. A favourable development was also recorded in the development of flats in family houses, which increased by 9.4% year-on-year. The number of flats in this category reached 21,271, which was higher than the number of flats started before the 2019 coronavirus pandemic.

There was also an increase in the number of housing starts in family houses, where 1,882 flats were started, and 1,676 flats in non-residential premises. There were fewer flats year-on-year in retrofitting of existing residential buildings, with 2,946 flats but where there was a high comparative base in the previous year due to refurbishments and upgrades to flats then underway, but still more flats were started in 2021 than in 2019.

The number of completed flats in 2021 reached a total of 34,581, with roughly the same number of flats completed as in the previous year. During the year, completions of under-construction flats declined, due to a lack of construction capacity as well as rising prices of building materials. The construction of flats in both apartment buildings and family houses remained at the 2020 level. In family houses, completed flats were most often 4+1 in size. In apartment buildings, as in the previous year, the largest share was the 2+1 flats, and about a quarter of flats were in the 3+1 size. In 2021, as prices rose, the cost of building flats increased, and this growth continued to accelerate. The cost of building a flat as well as 1 m^2 of living space was the highest in Prague, and this was true for flats in family houses as well as in apartment buildings. The living area of one flat per m2 in family houses was clearly the highest in Prague (114.4 m^2). The largest living area in apartment buildings was in the Karlovy Vary Region (67.1 m^2), while the smallest was in the Pilsen Region (40.7 m^2). The average area of 1 flat in the Czech Republic was 50.5 m^2.

For comparison, in 2022, 42.2 thousand of apartments started its construction, i.e. by 2.8 thousand less than in 2021. On the other hand, there were 39.4 thousand apartments completed, i.e. approx. 15% more than in the previous year. Overall, it can be concluded that in 2022 housing construction in the Czech Republic maintained a dynamic development.

4.9. Housing stock and its energy performance

New housing construction is only very slowly changing the overall volume and quality structure of the existing residential and housing stock. Its extent is monitored by the Czech Statistical

Office as part of the statistical survey 'Census of Population, Houses and Flats' (CPHF). The census is carried out every ten years. The last two were carried out in 2011 and 2021.

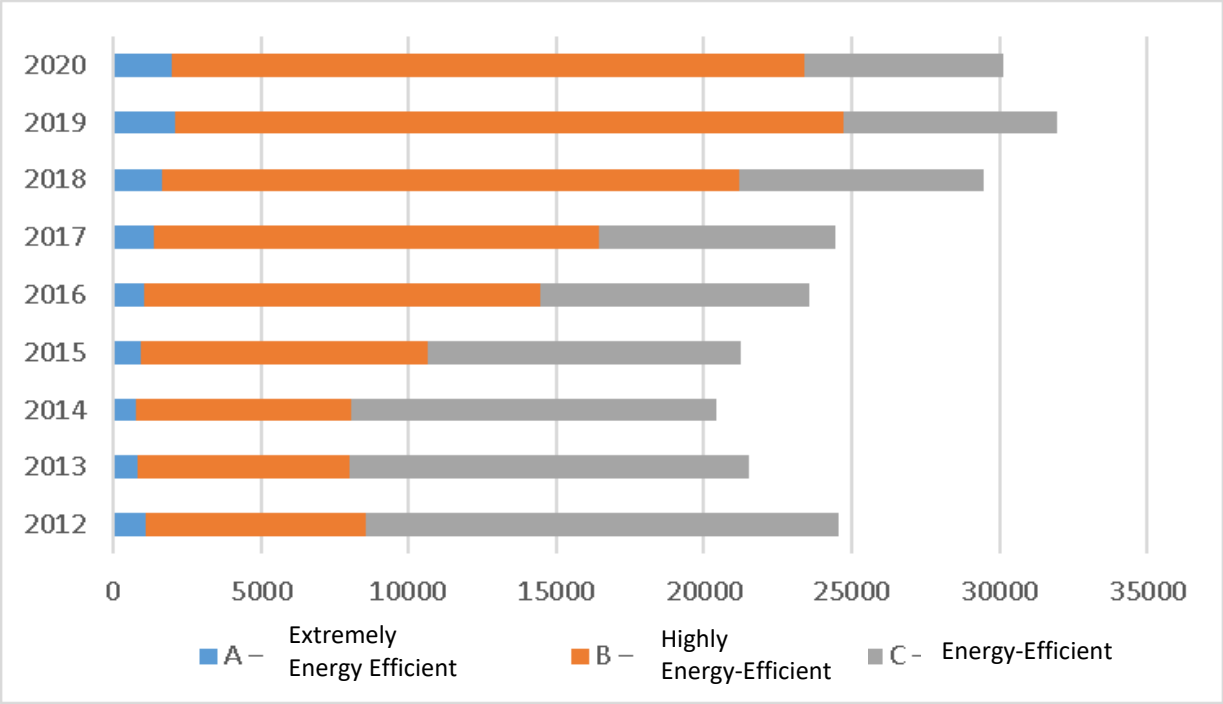
It is all the more important to monitor the growth of the energy standard of buildings in new constructions (including renovations). Statistics on completed houses and flats categorized according to the energy standard achieved on the basis of certification according to Decree 78/2013 Coll. on the energy performance of buildings is a useful indicator.

Table 9: Comparison of the increase in the number of houses between 2011 and 2021

Source	Number of houses	Number of Occupied Houses	Family houses	Apartment houses	Other buildings
CPHF 2011	2,158,119	1,800,075	1,554,794	211,252	34,029
CPHF 2021	2,317,276	1,952,668	1,709,845	207,540	35,283
Change	159,157	152,593	155,051	-3,712	1,254
Change (%)	6.87 %	7.81 %	9.07 %	-1.79 %	3.55 %

Sources: (CSO, 2022)

Figure 5: Development of house construction in terms of energy efficiency



Source: SEVEn, based on CSO data

The presented graph clearly shows that a minimum number of apartment and family houses in energy class A are being built so far (on average 145 flats/year in the period 2012-2020).

Most houses, both apartment and family houses, are now being built in category B, while at the same time a significant shift from worse to better energy categories can be seen over the years. The trend towards better energy categories can be expected to continue in the coming years, especially in response to gradually increasing energy efficiency requirements and technological advances.

Table 10: Number of completed flats by energy performance class

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Flats in total	29 467	25 238	23 954	25 095	27 322	28 569	33 850	36 406	34 412
Of which in new family houses and apartment buildings	24,537	21,518	20,414	21,246	23,565	24,434	29,457	31,945	30,113
A – extremely energy efficient	1098	806	783	952	1065	1367	1,680	2,087	1,973
B – highly energy efficient	7,460	7,175	7,254	9,725	13,382	15,074	19,482	22,644	21,411
C – energy efficient	15,979	13,537	12,377	10,569	9,118	7,993	8,295	7,214	6,729

Source: CSO

Based on the Long-Term Renovation Strategy [13], developed by the MIT, the data for the renovation rate for family houses were determined using the available information on renovations of family houses from the New Green Savings Programme and data from the ENEX database (which contains information from documents prepared by national energy experts, i.e. from energy audits, energy assessments, building energy performance certificates and reports on the inspection of heating and air-conditioning systems).

For apartment buildings, there is more precise information on renovations. Details of the implemented energy saving measures are obtained from the ENEX database and from information from support programmes used for the renovation of apartment buildings such as the New Green Savings, Panel 2013+ or the Integrated Regional Operational Programme (IROP).

[13] https://www.mpo.cz/assets/cz/energetika/energeticka-ucinnost/strategicke-dokumenty/2020/6/_20_III_dlouhodoba_strategie_renovaci_20200520_schvalene.pdf

For non-residential buildings, renovation rates were based on building permits for major building alterations and partly on the ENEX database. However, renovations that are not of the nature of energy saving measures are also part of the building permit.

The extent of the renovation was determined by the energy performance class of the building, i.e. which class the renovation achieved. Building energy performance classes A and B were determined as thorough and deep renovation levels, class C as medium renovation level and classes D, E, F and G were determined as shallow renovation levels.

Table 11: Annual rate and depth of renovation in the Czech Republic, in the period 2014–2018

	Residential sector		Non-residential sector	
	Family houses	Apartment houses	Public buildings	Commercial buildings
Renorate	1.40 %	0.79 %	1.40 %	
Renovation depth*				
Shallow (D, E, F, G)	35.0 %	31.1 %	28.08 %	26.13 %
Medium (C)	45.0 %	49.6 %	41.03 %	44.67 %
Thorough (A, B)	20.0 %	19.3 %	30.90 %	29.21 %

** Weighted average for apartment buildings*

Source: (MIT, 2020)

The definition of thorough renovation is not entirely consistent with the EC's use of the term deep energy renovation. A thorough renovation represents an achieved standard rather than a level of improvement.

Table 12: Depths of renovations carried out in the period 2014 - 2018 for apartment buildings by ownership

Depth of renovation	Cooperative	Individuals and legal entities	Apartment owners association	Municipality/state
Shallow	28 %	34 %	30 %	33 %
Medium	57 %	35 %	58 %	41 %
Deep/Thorough	15 %	31 %	12 %	27 %

Source: (MIT, 2020)

The proportion of buildings already renovated has been estimated. This percentage is 25% for family houses and 40% for apartment buildings (prefabricated houses alone are renovated to the extent of 55%). This is based on internal surveys, estimates by consultancies, statistics on support programmes, the amount of ETICS (contact thermal insulation system) sold and, in the case of apartment buildings, the PanelScan study16[14].

The extent of new construction by building type is shown in the table below.

Table 13: New construction and demolition

	The rate of new construction	The rate of demolition
Family houses	1.11 %	0.20 %
Apartment buildings	0.46 %	0.10 %
Non-residential buildings	0.96 %*	0.20 %

** Lowered by 15% (based on data from the Non-Residential Buildings Survey) due to the deduction of unheated areas such as warehouses and garages.*

Source: (MIT, 2020)

According to Article 9 of EPBD II, all new buildings occupied and owned by public authorities were to be nearly zero-energy buildings from 1 January 2019 and all new buildings in general by 31 December 2020. When transposed into Czech legislation, this requirement was tightened in Act 406/2000 on energy management, namely that all new buildings should meet the nZEB standard already as of 1 January 2020. It can be assumed that for the next few years, construction of older projects (with extended building permits) was still ongoing. If not redesigned, these buildings may have a lower energy standard. However, from the beginning of 2020, it is mandatory that all buildings already meet the nZEB standard, i.e. a higher energy class.

In the Czech Republic, the legislation on heat transfer coefficients (ČSN 73 0540-2:2011 Thermal protection of buildings - Part 2: Requirements) was set in such a way that if the recommended values of the heat transfer coefficient were met, using appropriate technologies and renewable energy sources, it was possible to meet the requirements for nZEB already several years before

[14] Study of the condition of the housing stock of prefabricated housing in the Czech Republic, CERPAD for the Ministry of Regional Development, 2009

2019. As early as in 2010, 2.83% of new family houses and apartment buildings in the Czech Republic were built in the nZEB standard[15].

The following table describes the development of the share of buildings in the nZEB standard in the Czech Republic from 2010 to 2016.

Table 14: Share of newly built family houses and apartment buildings.

Level	New FH and AB standard	2010	2011	2012	2013	2014	2015	2016
1	Better than nZEB (passive houses)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	According to the national nZEB	2.83	3.62	3.61	4.15	4.36	3.95	3.70
3	Better than the requirements of the Building Act, but not meeting the nZEB definition	26.91	28.57	27.80	28.22	29.44	32.81	29.63
4	According to the requirements of the Building Act	70.25	67.81	68.59	67.63	66.20	63.24	66.67

Source: Project ZEBRA2020, 2017

Between 2010 and 2016, the construction of family houses and apartment buildings in the nZEB standard was 3-4%. However, at that time, legislation specifying the compliance with the nZEB standard was not yet in force. Further 26-28% are buildings that perform better than the standards required by CSN 73 0540-2:2011, so it can be assumed that a change in the technology used, or the use of renewable energy has taken this group up a notch and the achievement of 100% construction of new buildings in the zero-energy building standard by 2020 has been achieved.

4.10. Energy consumption and renewable energy in buildings

Table 15: Final energy consumption in households between 2014–2020, PJ

Year	2014	2015	2016	2017	2018	2019
PJ	274.41	283.43	296.85	301.57	294.86	293.36

Source: Eurostat, 2021

The largest share, 40% of the total final energy consumption in the Czech Republic, is consumed by households, i.e. family houses and apartment buildings. Household final consumption

[15] https://www.mpo-efekt.cz/upload/7799f3fd595eeee1fa66875530f33e8a/efekt-rozvoj-a-dopady-zavadeni-budov-s-temer-nulovou-spotrebou-energie-v9.pdf

represents the amount of energy needed to meet the energy needs associated with the use of the building, mainly for heating, cooling, ventilation, humidity control, hot water and lighting, but also includes the consumption of household appliances.

Table 16: Development of final consumption of basic fuel categories in households

[PJ]

Fuel/energy	Year				
	1990	2000	2010	2015	2020
Electricity	35	50	54	52	58
Purchased heat	52	51	52	43	41
Natural gas	38	86	100	75	78
Solid fuels	129	38	40	35	27
Liquid fuels	4	3	1	2	2
Renewable energy sources	43	42	65	78	95
Total	301	270	312	283	299

Source: Calculation by the CSO from Eurostat energy balance

Between 1990 and 2020, total annual final household energy consumption remained virtually unchanged, though after a decline in the early 1990s there was a dynamic increase with a peak in 2010. Since then, consumption has fallen again, albeit by 'only' 6%. This is due to the increase in household living standards and the increase in the number of households. On the other hand, average annual final energy consumption per household has decreased by 12%, which means that there is an overall improvement in the energy efficiency of housing. The average annual final energy consumption per person has decreased by 6.3% from 30.35 GJ to 28.45 GJ. More importantly, the share of renewable energy sources in total household energy consumption is steadily increasing.

Table 17: Household final fuel and energy consumption by purpose of use

Fuel/Energy	Total	2020					
		According to the purpose of use					
		Heating	Water heating	Cooking	Lighting and appliances	Cooling	Other uses
Final consumption in households	**299,272**	**203,519**	**49,763**	**18,922**	**21,827**	**233**	**5,007**
Electricity	**57,501**	10,405	12,136	8,664	21,827	233	4,236
Natural gas	**77,707**	51,459	16,933	9,315	x	0	0

Purchased heat	**40,862**	27,576	13,286	0	x	0	0
Solid fuels	**26,563**	25,819	730	15	x	0	0
Liquid fuels	**2,012**	1,579	0	433	x	0	0
Renewable energy sources	**94,627**	86,683	6,678	495	x	0	771

Source: CSO calculation from the International Household Questionnaire

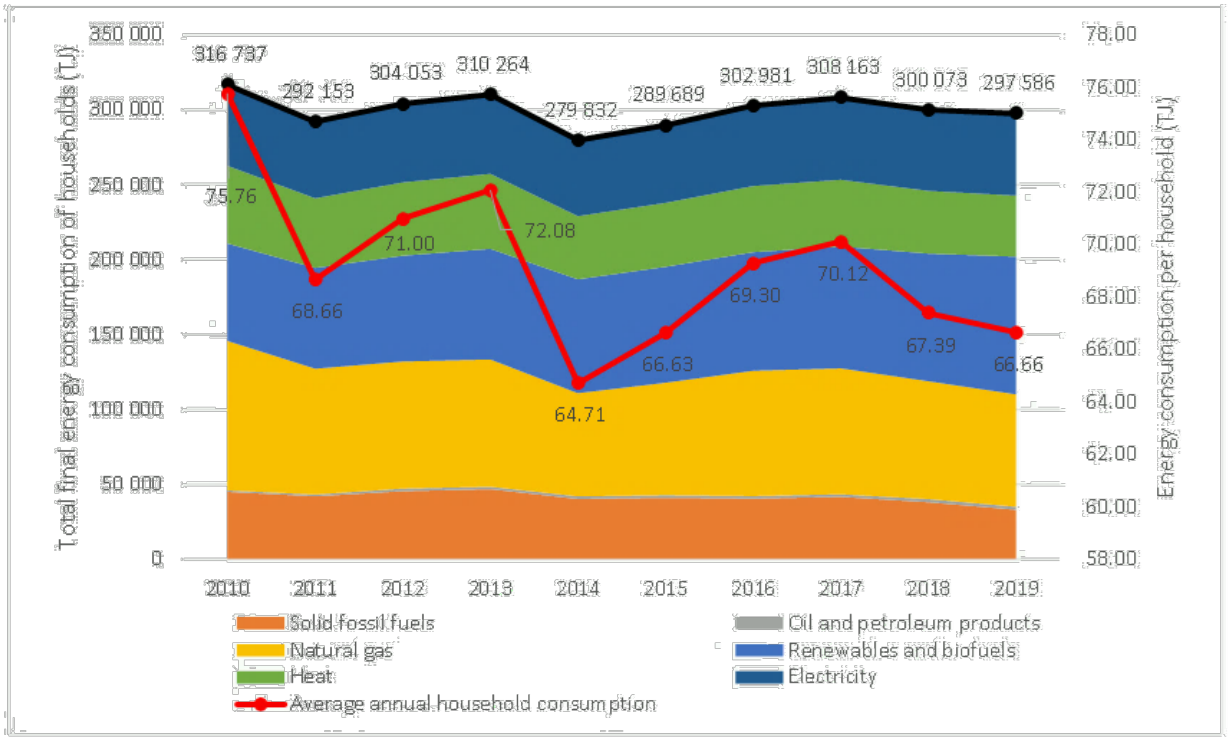
In 2020, 68% of total fuel and energy consumption was used for domestic heating. Households used less than 17% for domestic hot water, 6.3% for cooking and over 7% for lighting and consumption of large appliances.

It is therefore logical that it is the savings in heating costs that have received the biggest attention in the recent period, in the form of insulation. It is also important to monitor the insulation of flats in terms of the individual construction periods. The most frequent category of flats without insulation concerns those built before 1970. These flats also have the most outdated materials and technologies from which they were built and are therefore the most fuel and energy intensive without insulation. Of the total number of flats built before 1970, almost 26% were without any form of insulation in 2015. By 2021, the share of these flats has fallen to 21%. Thus, there has been a reduction in energy intensive housing over the period monitored. A closer look at flats in family houses and flats in apartment buildings shows that a higher proportion of non-insulated flats is in family houses. In the case of family houses built before 1970, nearly 32% were uninsulated in 2015. In 2021, this proportion dropped to 26.3%. This trend is also true for apartment buildings. Of the apartment buildings built before 1970, over 20% were without any insulation in 2015. In 2021, this proportion dropped to 16.7%. Together with the current construction period, the proportion of flats without any insulation is decreasing.

According to the EUROSTAT-SHARES methodology, the share of renewable energy in final energy consumption exceeded 16% [16] in 2019. According to the national methodology, however, it was already about 24%.

[16] https://www.mpo.cz/assets/cz/energetika/statistika/obnovitelne-zdroje-energie/2021/9/Obnovitelne-zdroje-energie-2020.pdf

Figure 6: Total final energy consumption of households and average energy consumption per household in 2010/2019



Source: (Czech Statistical Office, 2021), (Ministry of Industry and Trade, 2021)

5. Current situation in the field of education and training

5.1. Labour market – workforce and its qualifications

The construction sector differs significantly from other manufacturing sectors in terms of the nature of the work, the technologies used, the changing conditions of the site and the type of construction. In a number of aspects, it is not comparable to any other industrial activity. Although new technologies, machines, materials and processes reduce the physical demands of work and increase its productivity, the basic nature of the activities, and thus the requirements for the professional structure of the staff, remain essentially unchanged or change slowly. The construction sector will continue to be (at least for the foreseeable future) a sector heavily dependent on skilled manual labour.

As regards the requirements of the construction sector in terms of securing the workforce, **the situation is steadily deteriorating**. The average age of the employees is constantly and disturbingly increasing (now about 45 years). In the manual worker occupational group (craft trades), the situation is downright alarming. The first prerequisite for changing the unfavourable trend in the development of the age structure is an increase in the number of **young people entering the profession**. It is therefore a matter of adapting primary education institutions, from apprenticeships to universities, to the demands of the construction sector. The second prerequisite is the development of a **lifelong learning system**, where the growth or change of qualifications among adult employees is at stake – again in relation to the changing demand of construction companies.

5.2. Primary education

5.2.1. Secondary schools

After many years of a decline in interest in construction disciplines, related not only to their low attractiveness but also to negative demographic development, interest in construction fields in secondary schools has increased over the past four years. Between 2018 and 2021, the number of new enrolments in them grew from 4,324 to 5,344, and their share rose from 5.6 to 6.2 per cent of all secondary school enrolments. The increase even exceeds population growth. Statistics from the Ministry of Education show that the number of entrants to the first year of secondary school rose by about 10 per cent between 2018 and 2021. The construction trades are up by about 24%.

The growth in interest in construction is particularly true for apprenticeship courses! The proportion of new apprentices in them has risen from 7.5% since 2017 to 9.4% of pupils entering their first year last year. By contrast, the proportion of new entrants in school-leaving

certificate programmes rose as early as 2016 to 2018 and has rather stagnated in recent years. New entrants in the high-school-leaving certificate construction majors accounted for about 5.1 percent of all freshmen last year.

The relatively significant increase in pupils entering construction training courses is not only influenced by long-term support and promotion, but also in the last two years by a drop in the availability of jobs in the gastronomy sector, in which a long-term decline in interest has been reinforced due to the Covid-19 pandemic. The impact of the pandemic can probably explain the spike in 2020, when the proportion of new entrants in secondary school-leaving exam construction courses rose from 5.1 to 5.5 per cent. This is also evident in the stagnation of the number of new construction courses in the 2022/2023 school year.

Building apprenticeship courses are taught in 140 schools in the Czech Republic and school-leaving certificate courses in 51 schools. The most popular apprenticeship courses include mechanic of gas equipment, plumber, floor layer and bricklayer, while the most favourite school-leaving certificate courses are construction, geodesy, and land registry. On the other hand, there is little interest in the glazier, roofing and tiling apprenticeships. In recent years, tinsmith, water supply and sewerage installer, or pipe fitter have not even opened due to a lack of applicants. There is also very little interest in the school-leaving certificate course focused on building materials.

Table 18: Development of the number of new enrolments in construction fields in secondary schools:

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number of new entrants to the construction courses	5,788	5,417	4,741	4,309	4,283	4,114	4,324	4,687	5,126	5,344
Proportion of all secondary school enrolments	7.3 %	6.9 %	6.1 %	5.6 %	5.6 %	5.4 %	5.6 %	5.9 %	6.3 %	6.2 %

Source: NPI

Table 19: Development of the number of new enrolments in the construction apprenticeship courses:

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number of entrants to the construction apprenticeship courses	3,577	3,327	2,773	2,443	2,371	2,198	2,259	2,496	2,656	2,830
Percentage of total enrolments in apprenticeship courses	10.8 %	10.5 %	8.9 %	8.1 %	8.1 %	7.5 %	7.7 %	8.1 %	8.7 %	9.4 %

Source: NPI

Table 20: Development of the number of new enrolments to secondary construction schools with school leaving examination courses:

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
The number of entrants to secondary construction schools with school leaving examination courses	2,211	2,090	1,968	1,866	1,912	1,916	2,065	2,191	2,470	2,514
Percentage of all students enrolled in school leaving examination courses	5.5 %	5.2 %	4.9 %	4.6 %	4.7 %	4.7 %	5.0 %	5.1 %	5.5 %	5.1 %

Source: NPI

The positive features of the recent development of interest in the field of construction in secondary schools should not be overestimated. There are five reasons for this:

a) The current fluctuation is largely caused by demographic developments, so once the demographic wave has passed, another decline is to be feared;

b) Students with low academic aptitudes and low motivation to work often enter construction apprenticeships, and partly also courses with the school-leaving certificate – maturita). Moreover, according to current estimates, on average around 40% of graduates leave for other fields within five years of finishing their studies;

c) The relatively high (official) unemployment rate of graduates of predominantly vocational schools (5.5%[17] compared to the average of 3.0%) does not necessarily mean that these fields are not marketable. Indeed, these are occupations where people often turn to the informal economy and remain officially unemployed. The reasons why some choose to work 'outside the system' are not only financial, but often also due to administrative burdens or other regulatory barriers;

d) Even if such a large " fall-out " did not exist, the current (higher) annual numbers of graduates do not cover the annual decline of craftsmen leaving the field;

e) The structure of young people's interest in the various fields does not correspond to the structure of construction companies' needs for qualified professionals.

Yet, when it comes to **graduates of secondary vocational (industrial) schools**, quality, not quantity, is the major problem at present. Here, too, it is necessary to focus more on the acquisition of skills that can be used in future practice, both theoretical (ICT) and practical, with more profound knowledge, and at the same time to increase knowledge in the area of working with people. As the acquisition of practical experience must be an essential part of the learning in this area of secondary education, this requires greater involvement of specialists from practice and the related active participation of business entities.

As far as **vocational school graduates** are concerned, the availability of craft occupations for the construction industry is perceived as a major long-term (yet acute) problem of the construction labour market. The total number of people interested in vocational trainings is so low that vocational schools' capacities are mostly not used up, classes of apprentices from different vocational backgrounds are combined and some courses are not open at all in the year in question.

Table 21: Development of the number of graduates in selected fields of crafts 2005-2018

	Number of graduates 2005	Number of graduates 2018	Change 2005-2018
Occupations in furniture making			
Upholsterer	163	40	- 75%
Joiner	2,596	776	- 70%
Construction professions			

[17] The unemployment rate of graduates in vocational fields: Roofer 10.4%, Painter and Lacquerer 9.1%, Tinsmith 6.4%, Drywall Installer 12.0%, Bricklayer 7.0%, Stonemason 14.3%, Plumber 5.9%, Chimney Sweep 5.8%, Floor Layer 2.6%, Stonecutter 14.3% (AMSP survey, February 2019).

	Number of graduates 2005	Number of graduates 2018	Change 2005-2018
Chimney sweep	4	111	+ 2,675%
Gas equipment mechanic	16	31	+ 94%
Roofer	74	20	- 73%
Bricklayer	705	253	- 64%
Painter and varnisher	135	49	- 64%
Dry construction fitter	84	36	- 57%
Stonemason	11	6	- 45%
Plumber	1,070	668	- 38%
Floor fitter	31	22	- 29%
Carpenter	231	170	- 26%

Prepared by the team of the Association of Small and Medium-sized Enterprises and Tradesmen of the Czech Republic, February 2019

5.2.2. Universities

In terms of the demand-supply ratio in the construction industry, **university graduates** represent the least problematic group. The total number of students in the fields of construction and architecture currently reaches about 13,000, and although they represent only 4 to 5% of all university students in the Czech Republic, on balance (with an annual number of graduates of about 2.8 thousand) they are sufficient for the needs of the Czech construction industry. However, there is a problem as regards the qualification profile of graduates. In order to prepare them comprehensively, it will be necessary to increase the share of teaching in economic disciplines, minimum basics of legal thinking (especially in the fields of administrative and commercial law), personnel skills in managing people, teaching foreign languages, construction organisation, project management, etc.

Figure 7: Structure of university students 2001-2021

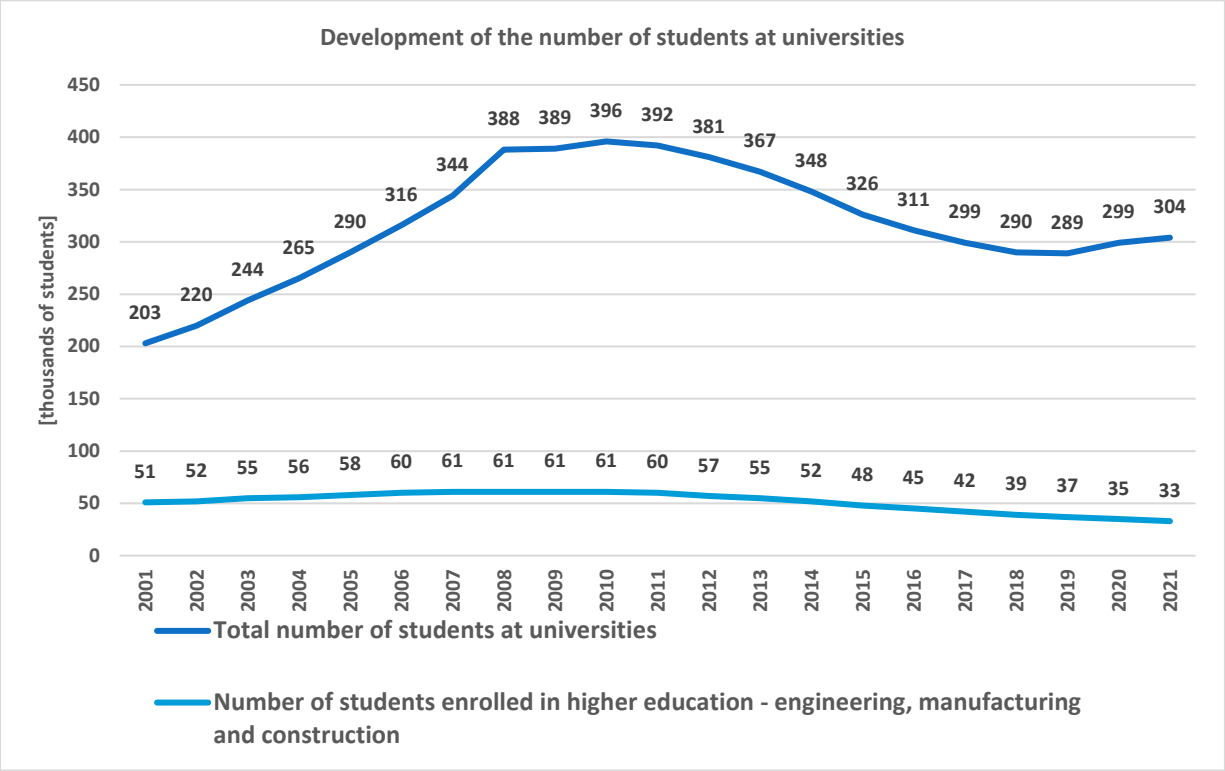


Table 22: List of Faculties of Architecture and Civil Engineering in the Czech Republic

Faculties of Civil Engineering and Architecture in the Czech Republic (31 December 2022)	
CTU - Civil Engineering	3.3k
CTU - architecture	1.6k
TU Liberec - construction	0.2k
BUT - Civil Engineering	3.5k
BUT – architecture	0.5k
VSB TUO - construction	1.2k
CZU in Prague - environment	2.7k
Total students at the following faculties:	13.0k persons (The average annual number of graduates is 2,800 persons)

5.3. Lifelong learning

5.3.1. Supply side

Analysis of the adult learning offer in the field

The supply of educational activities with all its parameters (volume, price, quality) varies quite sharply depending on whether it is:

A) Training according to Act No. 183/2006 Coll., 360/1992 Coll. or 312/2002 Coll. ("organized");
B) Regular ("voluntary") education.

The volume-critical performances are carried out within Group A. This is because the law states that:

- **education is compulsory**;
- chambers or local self-government units **are obliged to ensure** a system of qualification improvement and to develop a training plan, which in the case of the CCA (ČKA) and ČKAIT (Czech chamber of chartered engineers and technicians engaged in construction) works with the need to obtain a certain number of "credits", in the case of local self-governments directly defines the schedule for improving the qualification of an official in the scope of at least 18 days for the next three years (or an average of 6 training days per 1 year);
- trainings can be provided by **organizations recognized by the chambers** or by training programmes of accredited institutions **accredited by the Ministry of the Interior**;
- the law stipulates a **continuous training obligation** throughout the entire period of professional activity.

These laws therefore generate a significant and stable demand for education, while tying the meeting of this demand to certain qualitative requirements – "recognition" or "accreditation". For this reason, competition on the supply side takes place only between a part (although large) of educational organizations, through "recognized" or "accredited" programs. At the same time, however, the numbers of these programmes are set quite generously, both in total and in individual disciplines. It is therefore the rule that several dozens of 'authorized' organizations offer the same or similar courses.

Despite the highly competitive environment, this segment of the market is **very attractive** for education providers: higher quality (at least from a formal point of view higher) education and

at the same time its higher (because legally dictated) attractiveness for buyers leads to higher prices implemented, in conditions where the measurable costs of the implementation of the given courses can be significantly reduced (e.g. due to their repeatability, customer implementation, etc. Here too, however, the situation is diversified in terms of the typologies of courses defined by law – in sum, ordinary (usually one-off) training is relatively the least attractive, continuous training (usually long-term) is more attractive, training of managers even more so, and special professional competence training and verification is the most attractive.

As far as the group of external providers is concerned, the offer here is even more competitive: there are no legal limits, while the demand side is generally, albeit indirectly, limited by the aforementioned laws (those interested in education logically prefer "compulsory" activities to "voluntary" ones). The long-term success in this area is therefore brought about by an offer that is supported by active marketing, targeted at the current needs of the customer, offering high quality information at a reasonable price and at the right time and place.

Another important division of the supply side of the "education market" is the division between short-term and long-term courses. In general, on the supply side, long-term courses bring higher added value and therefore potential profit, but with higher risk of implementation. Short-term courses are less risky in terms of implementation, but this is (generally) matched by lower profitability.

From an organizational point of view, all the market segments outlined are intertwined: it is common for the same organization to offer both "compulsory" and "voluntary" courses, short- and medium-term. This makes the whole range of supply-side capacities rather difficult to determine.

Information sources on this topic are both incomplete and contradictory. Thus, there are **547 organizations in the Czech Republic** that have education as the subject of their activity, namely education that implicitly relates to the construction and building industry, or may have explicit "contact areas" with them (e.g. in the fields of organization management, etc.) (source: Commercial Register). However, this figure includes only economic entities registered in the Commercial Register, i.e. all commercial companies of all forms and selected individuals (larger, more important companies of this type). What is missing, on the other hand, are the 'smaller' self-employed persons, entities registered in other registers, i.e. non-profit organizations of all types, and finally also organizations for which adult education (especially in the given fields) does not represent the main field of activity, be it high schools or universities (using their professional capacities in this manner in a complementary way), or manufacturing companies (especially in the fields of production of building materials, construction equipment, but also in IT, etc.), for which training activities are often part of advertising or marketing. From this

extensive perspective, it would therefore be possible to estimate the total number of entities (at least potentially) forming the supply side of the market under study at **a minimum of 1, 100**.

Of these, however, only a small part can be described as entities operating in the Czech Republic on the market on a **stable and more than negligible scale**. A " clue" to how large a fraction this is provided by the register of ČKAIT and CCA (ČKA), which includes organizations of all the above-mentioned types whose educational activities are " rewarded" with credits for members of the above-mentioned Chambers. At present there are **267** such organizations. Some of them are, of course, also active on the "free" market, the number of other organizations operating exclusively on this market can perhaps be estimated at about **100-150**. Hence, the total number of active participants on the supply side of the adult education market in the construction and building sectors can be estimated at around **400 entities**.

However, even this group does not form a homogeneous unit, both in terms of the quantity of capacities offered, the degree of specialization, the way in which the supply is secured and, finally, in terms of the business strategy applied on the market.

As regards the total volume of supply, none of the organizations operating on the market can be described as dominant – the market is very fragmented in this respect, and even the most active entities still belong to the small group. The largest (in terms of volume of supply) of these small organizations are the less than seventy (69) organizations listed below.

First and foremost, it is clear that only a minority (16) of these organizations are not highly specialized. The ABF Foundation – the promoter of the Czech Building Academy project – belongs to this group. Together with ABF, universities (3), commercial companies (5), non-profit organizations (3) and professional roof organizations (4) are represented.

In contrast, the majority of organizations are very narrowly specialized in their range of offers, often (25) involving cases where the entities offering training courses actually promote their own products through them. This group also has a different business strategy, offering their courses for free or almost free, and covering the costs within the **promotion and marketing expenses**. The same tactics, however, are also used by a number of other "specialized" entities, which also function de facto as agencies of large companies within their field, which also cover (fully or mostly) the training costs. On the whole, it can be estimated that a decent half of the offered education capacities are offered to participants more or less free of charge. This, of course, makes the environment considerably more difficult for those organizations that have to offer their services for direct payment from their immediate customers.

ČKAIT organizes its own webinars, seminars, conferences and other professional events, and also accredits the professional training of external organizers who have applied for accreditation. In this way, the Chamber's members are offered a sufficiently wide range of

training. The ČKAIT Lifelong Learning Project is managed by the LLL Commission and technically provided by the ČKAIT Education and Information Centre. In 2021, the last year of the 7th run of the ČKAIT Lifelong Learning Project (LLLP) was underway, during which authorized persons had to prove their education during the years 2019-2021. The programme and conditions of the 7th run of the ČKAIT LLLP were published throughout the run on the Chamber's website. In 2021, a simple Q&A guide for ČKAIT members and training organizers was developed and published. Members were informed of the end of the 7th run in September 2021 by email.

In 2021, the LLL Committee approved the programme of the 8th run of LLL for the years 2022-2024 and a change in the form of the Certificate of Competence of CKAIT members, with validity already for the 7th run of LLL. The Authorized Person Certificate will be awarded to ČKAIT members who have fulfilled the conditions of the 7th run of LLL and delivered the Affidavit to their regional office in due time, by e-mail in PDF format. The programme of the 8th run of the LLL (for the years 2022-2024) was published on the Chamber's website at the end of 2021. An overview of accredited training is continuously updated in the LLL database on the Chamber's website. Searching in the database of events is possible using filters by place and date, organizer and thematic focus (keywords). The training organized by ČKAIT is also published in the date list on the Chamber's website, where authorized persons can also log in.

Similarly, the Czech Chamber of Architects (CCA) and 66 other professional societies organize educational activities for their members (see Table 24).

Table 23: Overview of their member societies (individuals and legal entities) providing training, authorization and lifelong learning

	Professional association, guild, chamber	Legal entities and individuals	Websites	Number of persons with authorization	Profession
1	Association of swimming pools and saunas	300	http://www.abascr.cz/	300	Operators and builders and services
2	Association of heating technology companies	20	http://www.aptt.cz/	743	Biomass boiler fitter
3				170	RES heat pumps installer
4				23	RES solar systems installer
5	Pressure Equipment Workers Association	32	https://atz.cz/	not stated	pressure vessels and welding

6	Association of Entrepreneurs in Geomatics, z.s.	64	www.apgeo.cz	500	preparation of the Czech Chamber of Surveyors
7	Association of Pipeline and Product Pipeline Builders	44	https://aspp.cz/	44	Supply companies
8	Guild of upholsterers and decorators and joiners z.s.(Prokopová)	61	https://www.cech-cal.eu/	80	Upholsterer, decorator, joiner
9	Guild of Stove makers of the Czech Republic z.s.	164	https://www.cechkamnaru.cz/	220	Stove maker
10	Guild of timsmiths, roofers and carpenters Czech Republic Association	165	https://www.cech-kpt.cz/	268	Carpenter, roofer
11	Guild of Painters, Varnishers and Paperhangers of the Czech Republic z.s.	189	https://www.cechmal.cz/	205	Painter, varnisher
12	Guild of Tilers of the Czech Republic z.s.	101	https://www.cech-obkladacu.cz/	207	Tiler
13	Guild of Parquet Layers of the Czech Republic	18	http://www.cechparketaru.cz/	36	Parquet layer
14	The Guild of Floor covering installers of the Czech Republic z.s.	120	https://www.cech-podlaharu.cz/	315	Floor covering installer
15	Guild for Building Insulation of the Czech Republic z.s.	47	https://www.czb.cz/	105	insulation of buildings (ETICS)
16	Guild of Dry Construction of the Czech Republic, z.s.	119	https://www.cechsv.cz/	3 831	92 assembly companies, 10 manufacturing companies; 7 sales

	(certified for assembly)				companies and 10 schools.
17	Guild of Heating Engineers and Plumbers of the Czech Republic z.s.		https://cechtop.cz/	10 000	installers of gas and water pipelines and air-conditioning systems as well as designers
18	Guild of Bricklayers of the Czech Republic z.s. (manufacturers and schools)	15	https://www.cechzednikucr.cz/	5000	bricklayer with an apprenticeship certificate of trained professionals
19	Czech Chamber of Lightweight Building Envelopes	48	https://www.cklop.cz/	5 000	Trained professionals
20	Brickmakers Association of Bohemia and Moravia	11	www.cscm.cz		association of manufacturers
21	RUDOLFINEA – association for artistic crafts		https://rudolfinea.cz/	neuvedeno	Artistic glazier, artistic carpenter and carver, artistic gilder, metal printer, artistic blacksmith and locksmith, art metalworker, artistic stucco plasterer, artistic painter, upholsterer
22	Association of Chimney Sweeps of the Czech Republic	875	https://www.skcr.cz/	875	
23	Society of Lifting Equipment Technicians z.s.	neuvedeno	http://www.stzz.cz/		crane and hoist installers
24	Society of Artistic Blacksmiths and Locksmiths, Blacksmiths-farriers of Bohemia,	157	http://www.kovari.org/	168	Artistic blacksmith, farrier, locksmith

	Moravia and Silesia, z.s.				
25	Association of refrigeration and air-conditioning technology	852	https://www.chlazeni.cz/	1 054	air conditioning installer and other professions
26	Association of Stonemasons and stone carvers of the Czech Republic z.s.	86	http://kamenici.cz/	320	Stonemason and other professions
27	Union of the Lift Industry	80	https://uvp-cr.cz/	400	fitters, electricians, locksmiths, welders, etc.
28	Association of Suppliers of Prefabricated Houses	108	https://www.admd.cz/	400	carpenters, assemblers, general contractors
29	Association of Small and Medium-sized Enterprises and Tradesmen		https://amsp.cz/		Unites guilds and associations, but also companies and individuals up to 250 employees alongside the Czech Chamber of Commerce
30	Solar association	699	https://www.solarniasociace.cz	699	operators, entrepreneurs, others
31	Association of Cement Producers of the Czech Republic	6	https://www.svcement.cz/	6	Complete company line up of manufacturers
32	Association of Manufacturing Industry	8	www.svaz.eu	8	Complete company line up of manufacturers
33	Czech Association of Steel Structures	48	https://caok.cz/	40	Complete company line up of manufacturers
34	SIA Czech Construction Council	13	www.siacr.cz	13	associations, chambers, unions, foundations

35	Foundation for the Development of Architecture and Construction	200	www.abf-nadace.cz	2 000	One-year graduates
36	Czech Association of Consulting Engineers (legal entities)	57	www.cace.cz	180	Consulting engineers
37	Czech Chamber of Architects	5664	www.cka.cz	1 929	VP General Authorization
38				2 391	A. Field of study architecture
39				158	SP. Field of spatial planning
40				237	LA landscape architecture
41				93	TSES designer of territorial systems of ecological stability
42				108	ID field of study Interior Design
43				1	SC Stage construction
44	Czech Chamber of Authorized Engineers and Technicians Active in Construction	33200	www.ckait.cz	16 715	Civil engineering
45				3 672	Transport constructions
46				1 128	Buildings of water management and landscape engineering
47				1 304	Bridges and civil engineering structures
48				4024	Technological equipment/ zařízeníá of buildings
49				3735	Building environment technology
50				1153	Statics and dynamics of buildings
51				157	Urban Engineering
52				511	Geotechnics

53				571	Fire safety in buildings
54				56	Buildings for the function of the forest
55				107	Testing and diagnostics of buildings
56				54	Energy auditing/ Energetiocké
57	Czech Construction Law Society	165	www.spolstavprav.cz	153	Construction lawyer
58	Czech Society of Construction Coordinators CSCC (ČSSI) z.s.	200	http://www.cssk.cz/	200	OSH coordinator
59	Czech Association of Civil Engineers	1200	www.cssi-cr.cz	1200	Czech Concrete Society ČSSI
60	Community of architects	800	info@obecarchitektu.cz	800	Architect
61	Association for Road Construction Prague	54	www.sdruzeni-silnice.cz	250	Construction company suppliers
62	Society for environmental technology	1300	www.stpcr.cz	1300	air conditioning, ventilation, heating, noise, alternative sources, health and industrial installations Integrated building design and assessment.
63	Association of Construction Entrepreneurs in the Czech Republic	320	www.sps.cz	320	Suppliers and manufacturing companies
64	Association of Energy Specialists	527	http://www.asociacees.cz/	1341	Energy Specialist
65	Association of Testing Laboratories for Construction	58	www.szv.cz	58	Accredited testing laboratories
66	Association for urban planning and	242	www.urbanismus.cz	242	Individuals

	spatial planning of the Czech Republic				
67	CZ BIM	64	https://www.czbim.org/	120	companies with BIM experts
68	NCS 4.0	28	https://www.ncs40.cz/	35	companies, associations, schools
Number of organized individuals and legal entities associated in professional societies, chambers and guilds		**48 529**	number of authorized bodies, both individuals and legal entities, with lifelong learning	**77 333**	total number of registered persons in LLL in the construction industry in the Czech Republic (excluding education in public administration and self-administration

All the above-mentioned associations are aware of the need to build skills in lifelong learning to integrate renewable energy and efficient heating technologies (in particular the introduction of heat pumps and the integration of solar panels[18]), as part of renovation projects and to this point are prepared to accept the Roadmap proposals, based on the SQA.

5.3.2. Demand side – enterprises

In 2020, 90% of enterprises in the construction sector (with more than 10 employees) provided any kind of training for their employees. However, if we do not take into account the mandatory training required by law (such as Occupational Safety and Health and Fire Protection), then 50% of enterprises were providing training. Both figures are more or less comparable to the total number of enterprises without distinguishing between sectors.

In terms of non-statutory forms of training, construction enterprises used almost exclusively courses/training (37 %) and on-the-job training or coaching (24 %), with minimal use of other forms.

In 2020, an average of CZK 2,209 per employee was spent on education in construction companies, which is about 10% less than the average for all companies. This expenditure was mainly influenced by relatively higher costs for courses (2,475), while savings were made on

[18] Between 2021 and 2022, the installed solar capacity in the country increased from 62 MWp to 289 MWp (From the Solar Association's 2022 Annual Report)

other forms of training. The share of education costs in total labour costs was 0.4%, i.e. the same as the average for all enterprises. Typically, a significantly higher share is covered by larger construction companies and, in particular, by companies with foreign capital. Courses, but also other forms of education, are predominantly provided by ordering them from an external training company.

One of the weaknesses of training in construction companies is their low planning, especially when it comes to non-compulsory training. Some form of an education plan exists in only 42% of companies, but only 16% of these have a binding plan. This is significantly less than for all enterprises combined. The size structure of construction companies is clearly a strong factor – small companies prevail, generally placing less emphasis on education.

Only 19% of construction companies regularly assess the benefits of employee training for the running of their business (by far the 4th lowest proportion among sectors), and 47% do so irregularly. More than two-thirds of businesses in 2020 stated they were analysing what skills their employees would need in the future.

If a construction company discovers that the skills of its employees do not fully match what the company will need in the future, in half of the cases it tries to resolve the situation by training existing employees, in a quarter of the cases by finding new employees with appropriate qualifications and in a quarter by looking for "internal reserves" ("reorganization", etc.).

5.3.3. Obligation of certification for the installation of a heat pump

As of 1 January 2015, in accordance with Act No. 318/2012 Coll., persons carrying out installations of heat sources using renewable energy sources, including heat pumps, are required to have appropriate qualifications. However, the obligation only applies to installations that are financed through support programmes from state or European financial sources or through funds obtained from the sale of greenhouse gas emission allowances, for example through the New Green Savings Programme. The person installing the heat pump must meet two conditions:

1. a trade licence for the installation, repair and refurbishment of cooling equipment and heat pumps;
2. certificate of professional qualification No. 26-074-M installer of heat pump systems and small geothermal systems.

The following training centres are accredited by the Ministry of Industry and Trade (MIT) to carry out tests and issue certificates in the field of heat pump installation: the Training Centre for CHKT and CHP Ltd.

Act No 406/2000 Coll., on energy management, as amended, regulates the obligations of building owners when installing selected equipment using energy from renewable sources (RES). According to Section 7(4)(b) of this Act, only an certified person may install biomass stoves and boilers, photovoltaic and photothermal systems, shallow geothermal systems and heat pumps. Installation by an authorised person is only required if the installation is a subsidised installation (usually under the New Green Savings Programme). The following table presents a summary of the certificates issued. The professions listed have also developed qualification and assessment standards.

There is no central registration of persons with relevant "authorizations" (chartered engineers and technicians) in the Czech Republic, and table 24 only summarizes the current estimates of the status of "authorized persons" based on a survey conducted by the ABF Foundation in 2023 for individual professional chambers and associations.

Due to the established specification of the professions in which the associations define authorizations, answers to cross-sectional questions such as the number of people with skills for the energy modernization of historic buildings cannot be found in the current statistics.

In most professions, these organizations are established as a voluntary association. However, from the overall evaluation of the qualification level of the Czech construction industry, it can be concluded with high probability that the number of people qualified for the energy efficiency and RES refurbishment of buildings (and not only historical ones) is not sufficient. This unfavourable situation is further strengthened by the fact that a significant proportion of workers are recruited mainly from Ukrainian citizens.

Table 24: Number of RES installers published in April 2023

Profession	Number
Solar Thermal Installer (23-099-M) (certificate issued as of 30 April 2023)	980
Installer of heat pump systems and shallow geothermal systems (26-074-M) (certificate issued on 30 April 2023)	3198
Biomass stove installer with hot water heat exchanger (36-148-H) (certificate issued on 30 April 2023)	122
Biomass boiler fitter (36-149-H) (certificate issued on 30 April 2023)	1506
Electrical installer of photovoltaic systems (26-014-H) (certificate issued on 30 April 2023)	4851

Source: Ministry of Industry and Trade How to become a person authorized to install selected equipment using renewable energy sources? https://www.mpo.cz/cz/energetika/energeticka-ucinnost/odborne-cinnosti/jak-se-stat-osobou-opravnenou-k-instalaci-vybranych-zarizeni-vyuzivajicich-energii-z-obnovitelnych-zdroju---167893/ Prague 2023

For the overall evaluation of the effectiveness of the educational system for the construction industry is missing the most basic thing – relevant and appropriately structured information. The national statistics do not provide the necessary data either at all or only in an insufficient form.

However, from the partial analytical data collected in this chapter, it is possible to derive the fundamental postulate, that the educational system for the needs of modern and sustainable construction reacts exclusively to **market impulses**, **with a delay and imprecisely**. There is still a lack of a useful educational policy that would predict the structural mismatch in the construction labor market well in advance. This is evident in the current skill development:

a) For implementing measures in the field of energy efficiency and renewable energy in buildings;
b) For carrying out in-depth renovation of buildings, including modular and industrialized solutions;
c) For new and existing buildings with nearly zero energy consumption (nZEB) and bridging the gap to zero emission buildings (ZEB) ;
d) For the integration of renewable energy and efficient heating and cooling technologies, including the introduction of heat pumps, in new and renovated buildings;
e) Related to the carbon footprint (through global warming potential assessment);
f) Supporting a higher energy efficiency of buildings, especially the use of building information modeling;
g) For the construction of smart buildings with higher energy efficiency, focusing in particular on sensors, building control elements and the control system;
h) Skills for energy modernization of historical (monumental) buildings.

As the results presented in this chapter show, there are also positive examples of response to the above-mentioned skill development requirements, but overall, the system remains quite conservative in this regard. A good example can be the universities of civil engineering and architecture (CTU FSv, BUT FAST, VŠB-TUO), which respond flexibly to topics related to the above-mentioned skills by including them in the study plans of bachelor and subsequent master's programs, during the accreditation of new study programs or the reaccreditation of existing ones. For example, at FSv CTU, the outputs of the Fit-to-nZEB project were incorporated into the curriculum of selected subjects, or the new study program Digitalization in Construction was supported and accredited within the NPO (National Renewal Plan). This was followed by a completely new professionally oriented master's program. Within the

framework of the NPO, sectoral innovations are supported, which include the topics of the mentioned skills in the course syllabus.

The situation is even worse in the field of secondary education and lifelong learning. The absence of regulatory and support measures from the state is felt greatly. The creation and purposeful implementation of the **concept of education in the construction industry** must therefore logically be one of the measures of the future Roadmap. This concept should contain both tools for predicting the development of the labour market in the construction industry, as well as tools for strengthening the attractiveness of the construction industry for women and for young and requalified people.

Even so, secondary education shows good examples of a positive response to the needs of modern and sustainable construction, e.g. the implementation of BIM in education. The development is gradual and depends on the skills of teachers who are engaged in other activities during working hours, including scientific research. Currently, it is a significant barrier in the development of education, but it is solvable. The younger generation of teachers responds flexibly to these trends. The issue of BIM is growing across all disciplines in subjects taught within ICT courses. There are few subjects that primarily deal with BIM. However, BIM as a main subject is still missing.

In the past, it was difficult to raise awareness about energy efficiency and renewable energies in buildings among teachers. They were reluctant to embrace this idea of at all (not to mention the implementation into teaching). There was a lack of practical information and examples of good practice, as well as theoretical materials for teaching. Over time, these barriers have been removed and further expansion into teaching is mainly blocked by the required skills of teachers.

Teaching energy management is a rather complex issue because it is not an isolated topic. It affects the entire construction industry and thus enters all areas of education. The implementation of such a complex method in educational programs therefore includes not only the creation of new content, but especially the modification of existing content. Taking into account the number and diversity of existing and planned study programs, it is very difficult to interpret current developments in the field of education in such a way that it is comprehensible even for non-academic or non-pedagogical environments, and at the same time has the necessary narrative value. This is escalated by the fact that the entire process of creating and approving educational content is quite long (at least 1 year or more) and any information presented can quickly become outdated. For the purposes of the SQA report, authors tend to refer to the topic in general rather than listing all subjects taught without context. However, it is worth noting that study programs focused on intelligent buildings are accredited at FSv CTU and FAST VUT.

6. Relevant construction skills projects

6.1. National Plan 2013

In 2013, the National plan for education in the construction sector towards Nearly Zero Energy Buildings[19] was developed, which included a proposal for measures to increase the number of qualified construction workers.

The document of the first National Plan contained specific activities that were intended to lead to the desired state of knowledge and skills of construction workers of different occupations. The measures adopted in the National Plan were aimed at ensuring an increase in the number of skilled workers who would be prepared and trained to carry out the conversion of completed buildings with poor energy performance into energy-efficient buildings, as well as for the construction of new buildings with almost zero energy consumption. **The projects included in the 1st National Plan can therefore rightly be considered relevant and have been assessed as such.**

For this analysis, the evaluation criteria for each measure were first established: relevance, coherence, effectiveness, efficiency, impact, and sustainability. According to these criteria, both the measures of the Action Plan and the financial instruments were evaluated, and the comparison resulted in recommendations for the development of the new National Plan of the Czech Republic.

During the implementation of the measures of the first National Plan, **the target for the number of educated staff and presentations/trainings was not sufficiently met**. For the new Action Plan, there is a need to focus more not only on the development of study materials but to use more financial resources to conduct training courses and trainings. There is also a need to focus more on awareness raising on the issue of construction of nZEB buildings and to try to involve not only public and educational institutions more, but also to involve private construction companies in education, which employ a significant proportion of the workers who will be active in the construction process in the next ten years.

[19] http://archiv.sps.cz/RDS/_PDFDoc_2013/BUILD-UP-Skills-roadmap-V14-12-7-2013.pdf

6.2. Recommendations for the development of the new National Plan

- Expand the topics of the National Plan for Education in Construction to include the current goals and areas of the Green Deal and the EU Taxonomy: Climate Change **Adaptation, Water, Circular Economy, Pollution Prevention, Biodiversity, Social Sustainability and Just Transition.**
- In addition, include the following target groups: vo**cational schools, universities of civil engineering, public investors, corporate investors and private investors, architects, planners, universities of architecture.**
- Like the first national plan, the new one should **incorporate specified measures** that reflect the focus of its action plan. Their selection should be determined on the basis of the outcome of the project team´s discussion. Each measure should specify a detailed description of the measure and the identification of its objectives; the objectives should ideally be specified **using the S.M.A.R.T. method**.
- **Setting the measure of the target number of educated persons in each target group**, as well as **the courses in which these numbers of persons will be educated** and the institution responsible for achieving the number of educated persons. It is also appropriate to establish **criteria for monitoring the behavioural change** of these people.
- **For the financial instruments, the new National Plan should include specific recommendations for the institutions coordinating the operational programmes** to ensure that the programmes are attractive to the relevant target groups and at the same time meet the objectives of the National Plan.
- It is necessary to focus on **graphic quality, clarity, and resourcing** to make the document attractive and understandable.
- Once completed, the National Plan for Education in Construction needs to be further **disseminated and promoted**, both among partner institutions, ministries and public institutions, and among the wider professional community: companies, consulting organizations, NGOs, universities, schools and others.

6.3. Evaluation of selected target groups of the Roadmap

Four groups of professions were selected for the National Roadmap and targeted by its measures. Primarily, professions directly involved in implementation were selected, i.e., designers, builders, construction company management, etc. were omitted. These professions are assumed to have easier access to new technologies and construction principles.

Selected groups of professions:

1. Basic "white collars" professions permanently working on the construction site:
   - Construction manager and construction supervisor, technical supervisor of the builder and author's supervisor
2. Construction craftsmen:
   - Bricklayers, insulators, tilers, locksmiths, fitters, carpenters, plumbers, plasterers, ...
3. Installation workers for building technology and technical equipment (HVAC)
   - Plumbers, heating engineers, RES installers, HVAC installers, ...
4. Electricians
   - (low-current, high-current, photovoltaic installations),
   - installation of lighting, measurement and control, alarm systems and other technological systems of the intelligent house.

The proposed groups of professions as the target group of the proposed measures of the Action Plan are chosen in line with the interest of strengthening the quality of construction, which is important in the use of modern technologies and practices. With the increasing need to maintain the quality of construction processes, the demands on the construction professions are also increasing, it is necessary that discipline is increased to maintain the proposed quality of construction. With increased knowledge of the building professions that perform the construction of modern structures, errors that would lead to degradation of the physical properties expected of the designed structures are eliminated. From this perspective, the selected groups are evaluated as correct with a high level of impact.

It is appropriate for the new action plan to consider the involvement of other professions that have an impact on the quality of construction. Focus on new professions that are created by the development of modern technologies and new working practices.

The first National Training Plan was primarily aimed at training workers who are directly on the construction site and can influence the quality of construction, but the training of workers with higher education, architects, designers, ... The demands of today's construction set high goals that must be addressed at the beginning of the design of the building. Along with the improvement of technical solutions and technologies, the importance of appropriate solutions for the building at the study and initial design stage, which are the responsibility of architects and designers, is increasing.

6.4. Evaluation of the Action Plan Measures

The Action Plan for Construction Education introduced by the BUILD UP Skills project in 2013 is one of the tools to achieve the implementation of the national plan. The action plan includes a list of actions that correspond to the long-term priorities of the national plan.

The action plan includes not only a list of measures and their description, but also timetables and expected implementation and financing. The measures proposed and presented in the first national RoadMap are the result of a comprehensive discussion. They are investment or non-investment measures of an educational or systemic nature. For each measure, the purpose, objectives, timeline, and key actors have been identified in a consistent structure.

6.4.1. Summary of the evaluation of the measures of the first Roadmap

Measure 1

Create a centre of lifelong learning for reference professions and build a Model Program of training courses for 'blue collar' craft workers, focusing on the new challenges as arising from the requirements on the energy performance of buildings.

Achieved - The Centre was created and opened in March 2017 in the premises of the ABF Foundation. The Czech Centre is part of the international network built within the Train-to-NZEB project in Europe.

Achieved - A model training programme for craftspeople has been developed within the CraftEdu project and a pilot course has been launched.

Measure 2

Lifelong learning for each of occupations under review - the use of craft manuals and curricula of lifelong retraining courses or exam preparation and retraining courses.

Achieved - Educational texts, training videos and e-learning training courses were created.

Not met - Training courses were organised through the Passive House Centre, CKAIT and the Train-to-nZEB and CraftEdu projects. The indicative target of training 60,000 people was not met.

Measure 3

Review knowledge and skills sets of individual occupations (as part of updating the NQF and NSO) in harmony with the EPBD Recast requirements.

Achieved - The qualification standards in the National Qualification System are being modified, a catalogue of knowledge and skills for 7 selected professions has been created within the CraftEdu project.

Measure 4

Creating qualification and assessment standards for construction supervision, technical supervision of the client and supervision of the author.

Achieved - In 2016, items were added to the National System of Professions (NSP), in 2020 the Czech Chamber of Authorised Engineers and Technicians Active in Construction published the Methodological Aid for the Profession Technical Supervision of Construction.

Measure 5

Create a database of blue-collar craft operatives also complemented with entries of their completed training courses.

Achieved - Within the CraftEdu project, a training system with evaluation and certification of course participants was created, participants are stored in the project database. The database is not publicly available.

Measure 6

The use of products and technologies quality assessment systems in terms of energy-efficient construction methods and making their results accessible for the blue collar craft professions.

Not met - the aim was to create a unified information system for the information and education portal, the evaluation programmes mentioned in the description of the measure are ongoing, but the unification of the information system has not been achieved.

Measure 7

Erect a model structure, as a permanent regularly up-dated exhibit showcasing current technical solutions, products and technologies while offering the chance to practice their employment methods.

Achieved - creation of an exhibition with exemplary models of construction within the Train-to-nZEB project, which were supplemented by models of reconstruction within the Fit-to-nZEB project.

Measure 8

Raising young people's interest in joining the construction industry.

Inconclusive - Determining the impact of the individual steps taken in the measure is very difficult, based on statistical data it is possible to observe a change in the downward trend of secondary pupil numbers, with a slight increase in attendance starting in 2017**.**

6.5. Evaluation of the financial instruments

In the National Roadmap, there were multiple sources of financing proposed to finance the activities. This part of the report analyses how the sources of financing performed during the assessment period. The financing options will be assessed by these criteria in regard to the National Roadmap of the Czech Republic and its goals:

- Relevance – how the funding is relevant to the scope of the National Roadmap;
- Coherence – how the funding is coherent with other programs;
- Effectiveness – how the funding manages to support the goals and activities in the National Roadmap;
- Efficiency – how many projects were realized thanks to this project relevant to the National Roadmap, what volume of financing was used;
- Impact – what is the impact of the financed projects relevant to the National Roadmap;
- Sustainability – what is the future of the funding, and if the funding programs continue.

Each program is assessed in these criteria only in the relevance to fulfilment of the goals in the National Roadmap in the Czech Republic for the blue-collar workers in construction, not in any other contexts.

Cost-free and Low-cost Measures

These measures were proposed in the national roadmap, and this paragraph includes evaluation of them:

Administrative fees in the education system: fees for educational programmes are not a common measure, as there is a wide offer of education programmes provided for free. However, there is a potential in the future as paid life-long education is becoming a trend in Czechia for both individuals and companies.

The education system may use different data available to various Government agencies: there has not been a systemic way realized to share information among different educational organizations and Government agencies. There is potential to elaborate on this option and include it in the new National Roadmap.

The cost-free measures should be included in the new National Roadmap as monitored Action Measures with clear KPIs and responsible institutions to increase the efficiency and impact.

EU Funds – Programs administered within the Czech Republic (individual Operational Programs)

For each of the programs it is assessed if the funds were used to finance projects which help to reach the goals of the National roadmap.

OP "Entrepreneurship and Innovations for Competitiveness" [20] with the MIT in charge: education in the construction sector was not specifically included and prioritized in this OP. OP included mostly financial support of physical investment and innovations. There was a category Consulting (PO2 SC2.1) which also included 50% funding of an education course for employees in SMEs in any area necessary for their skills-development for work: allocated funds 188 mil CZK, 209 projects applied, 40 projects were supported with the total funding of 22,9 mil CZK[21]. Another category educational centers (PO2 SC2.4) financed modernization of the centers' equipment with 50% rate: allocated funds 1150 mil CZK, 454 projects applied, 77 projects were supported with the total funding of 216 mil CZK[22]. The publicly available sources do not show which of the funds were used to finance education in the construction sector.

- Relevance – high
- Coherence – high

[20] https://www.agentura-api.org/wp-content/uploads/2020/06/prehled-programu-op-pik-2019-web.pdf
[21] https://www.agentura-api.org/wp-content/uploads/2023/01/statistika-op-pik-k-23.01.2023.pdf
[22] https://www.agentura-api.org/wp-content/uploads/2023/01/statistika-op-pik-k-23.01.2023.pdf

- Effectiveness – high
- Efficiency – low
- Impact – not enough information has been published
- Sustainability – not enough information has been published

This program is very relevant, and it could be used to finance life-long education and the physical capacities. However, only about 15% of the allocated funds were used to finance projects, which is a very disappointing result. There should be regular calls with conditions that are attractive to more applicants.

OP "Research, development and education" [23] with Ministry of Education in charge: education in the construction sector was not specifically included and prioritized in this OP. Life-long learning in universities is included in OP: one call Life-long learning was open in 2018 with available volume of funds 100 mil CZK, however, only projects in the value of 26 mil CZK were awarded and the rest of the funds remained un-awarded. The publicly available sources do not show which of the funds were used to finance education in the construction sector.

This program is very relevant, and it could be used to finance life-long education. However, it is only aimed at universities. Only one call applicable to life-long education was issued during the duration of the program and only 26 % of funds allocated to the call were used, which is a very disappointing result. There should be regular calls with conditions that are attractive to more universities.

OP "Employment" [24] controlled by Ministry of Labour and Social Affairs: One of the main priorities of the program is Adaptability of the workforce and education which support lifelong learning of the workers in all sectors in the Investment priority 3 of Priority axis 1 IP1.3 (Helping workers, businesses and entrepreneurs adapt to change). This is aligned with the goals of the National Roadmap. In total there were 14,9 billion CZK allocated to the calls in higher education of employees (plus 6,6 billion CZK as a support to employment in business during COVID pandemic). The information about awarded funds and number of projects is not publicly available.

This program is very relevant, and it could be used to finance life-long education. However, it is not directly aimed at the environmental topics, therefore there is higher competition among all organizations who apply for the call.

[23] https://opvvv.msmt.cz/download/file5847.pdf
[24] https://www.esfcr.cz/programy/op-zamestnanost

OP "Environment"[25] Controlled by the Environment Ministry: This program supports physical investments that help to reduce impact on the environment. Education of workers is not included in the program. In the category of Energy Efficiency, only public buildings are included.

This program is missing education as a priority and only limits itself on the physical investments. That is a big disadvantage as the priorities of the program do support the energy efficiency of buildings. However, without properly skilled workers the energy savings cannot be achieved in a sufficient quality and time.

OP "Integrated Regional Operational Programme"[26] controlled by the Ministry of Regional Development: This program has one part called Community-led Local Development (CLLD) which also includes support of life-long learning capacities. These programmes are administered by Local Action Groups (MAS) for each region outside of bigger cities, so bigger Czech cities cannot participate in this programme. Total number of supported projects in life-long education and allocated funds is not published.

This program includes life-long learning as its priority and many calls have been issued by the local action groups. However, it is not clear if any projects in education of construction workers were supported.

OP "Prague - Czech pole of growth"[27] controlled by the Prague City Hall: In the programme description, life-long learning is listed as a priority in the priority axis 4.1. However, it is not reflected in the calls, because all calls in the education priority axis are aimed at kindergartens, primary and secondary schools. No higher education is included.

This program could be very relevant as it includes life-long learning, however, as it did not publish any calls for higher education, it fails to support it.

U Funds – Programs administered directly by the European Commission for Transnational Projects

The Intelligent Energy II - Europe Programme (2007-2013): This program funded projects aimed at: Capacity building; building and spreading of know-how, skills and methods; exchanges of experience; development of market and intelligence; policy input; awareness

[25] https://2014-2020.opzp.cz/o-programu/podporovane-oblasti/
[26] https://irop.mmr.cz/cs/irop-2014-2020
[27] https://www.penizeproprahu.cz

raising and information provision; and education and training. According to the summary of the program[28], no Czech projects were funded in the program.

The relevance of this fund is very high as it aims directly at energy efficiency. However, as no projects from the Czech Republic were funded in the IEE, the efficiency was very low in the context of the National Roadmap.

There are other EU programs that continued after the IEE program such as LIFE and Horizon funding. These were not included in the first National Roadmap so they are not a subject of this analysis. They should be included in the revised National Roadmap.

Funds in the Czech Republic

Green Savings: There are 2 programs which are administered by the State environmental Fund of the Czech republic: **Zelená úsporám** [29] (Green Savings, 2009-2012) and **Nová zelená úsporám** [30] (New Green Savings, 2014-2023). However, both of them only fund physical investments in the renovation of buildings, especially family houses and multi-family residential houses. Education has not been financed in any of the programs.

There is a **program EFEKT**[31] financed by the Ministry of Industry and Trade which was not included in the National Roadmap. It is very relevant to the National Roadmap as its main topic is energy efficiency and it also includes calls related to education and spreading awareness. It should be included in the revised National Roadmap.

Foundations, Corporate Foundations, Foreign Foundations: as written in the National Roadmap, there is no suitable foundation program with a sufficient volume of resources that would be usable for Build Up Skills other than marginally. Foundation sector is more focused on financing low-cost community-based NGO projects. There are some international foundations and funds which offer funding that can be applied to the projects in education of workers in construction such as the German foundation Deutsche Bundesstiftung Umwelt (DBU), or the European Climate Initiative (EUKI) – a project financing instrument by the German Federal Ministry for Economic Affairs and Climate Action (BMWK). In the National Roadmap, further analysis of the possible sources of financing from the private or semi-private foundations should be included.

[28] https://energy.ec.europa.eu/system/files/2017-01/dgener_pda_-_executive_summary_rev_3.0_rev_0.pdf
[29] https://www.sfzp.cz/dotace-a-pujcky/ukoncene-programy/
[30] https://www.sfzp.cz/dotace-a-pujcky/nova-zelena-usporam/
[31] https://www.mpo-efekt.cz/cz/dotacni-programy/vyzvy

Funding by Vocational Education and Training (VET) Participants

There are several options of payments suggested in the National Roadmap which suggest refunds and some tools for motivation of the course participants. However, the most common option is for the participants to pay the fee regardless of whether they pass the course or not. The problem is the full costs of the higher education courses are high, and the freelancers are not willing to pay the full costs unless they need the qualification to perform their job. Therefore, mostly, part of the course fee is often covered by a grant, and the participant fees only cover a part of the costs.

The situation is different if the freelancers need the course as a qualification to perform their job. In that case they are motivated to pay for the course in full. This is however not the case in most of the professions in the construction industry. As the construction industry is lacking workers it is not advised to change this status because it could demotivate people even more. It is probably necessary to continue the partial support of the courses from public funds and grants to motivate the freelancers to participate.

Financing by Company (Supplier)

Financing of education by companies for their employees is a very common way of financing. The advantage is that bigger companies are used to paying the market prices for courses, therefore it is possible to offer programs for the full price. However, in the construction industry many smaller companies work with freelance workers, they do not have employees. This is very common for blue-collar workers, especially from abroad. These companies have limited motivation to pay for the education of their freelance collaborators. Different financing strategies for different types of companies should be elaborated on in the revised National Roadmap.

6.6. The lessons learned from the implementation of the first national Roadmaps and recommendations

Topics of the National Roadmap

The first National Roadmap included topics that were only related to energy efficiency. However, the current Green Deal objectives and the content of the EU Taxonomy[32] broaden

[32] https://ec.europa.eu/sustainable-finance-taxonomy/taxonomy-compass

the topics considerably and these areas need to be taken into account in addition to energy reduction and retrofitting:

- **Adaptation to climate change;**
- **Water;**
- **Circular economy;**
- **Pollution prevention;**
- **Biodiversity;**
- **Social Sustainability and Equal Transition.**

These themes should also be part of the revised National Roadmap.

Target groups and institutions

After comparison with foreign roadmaps, it is clear that the Czech national roadmap does not cover a sufficient breadth of target groups to achieve systemic change at all levels. It is recommended **to include the following target groups in the revision of the following roadmap**:

- **Vocational schools** - it is necessary to focus both on promoting young people's interest in studying in vocational schools and on teaching in vocational schools, updating the curriculum and improving the qualifications of teachers;
- **Universities with construction courses** - graduates become, for example, foremen, construction managers or project managers, and thus have a major influence on the construction workforce. It is necessary to focus on updating the curriculum in the light of modern technology and increasing the qualifications of teachers;
- **Public investors, corporate investors and private investors** - it is necessary to educate investors about the quality of work and the solutions they should demand from construction companies.

Setting measurable objectives (KPIs)

In the current National Plan, the measurable objectives were set more with regard to the creation of tools or learning programmes. Therefore, most of the objectives have been met. This means that in the revised plan the targets can be set more ambitiously. In order to monitor systemic change, measurable objectives (KPIs) need to be set that set **targets for the number of people educated in each target group**, as well as which courses these numbers of people will be educated in and which institution is responsible for achieving the number of people educated. It is also appropriate to establish **criteria for monitoring the behavioural change of these people, i.e. whether they apply the knowledge from the training courses in their practice**, which then has a real impact on improving the quality of construction projects. It is

advisable to use the SMART methodology for setting targets and to list all SMART aspects in the National Plan for each target.

For each measure it is necessary to clearly identify the responsible institution and to ensure that this institution agrees to be responsible for the measure when the revised National Plan is being developed.

Financial instruments

The analysis of funds and grant programmes shows that there are a number of operational programmes funded by EU funds that provide funding for lifelong learning and other measures. However, the problem is that none of the operational programmes is specialised in education for energy efficiency in the building sector. The problem with the operational programmes has often been the non-utilisation of the allocated funds. The reasons for non-utilisation may be multiple, but the available analysis shows that often only one or two calls were launched per programming period. Moreover, these calls often had only a few months between the announcement and the deadline for submission of the application, which is insufficient time for complex projects to prepare a good quality project application.

The revised National Roadmap should include **recommendations for the institutions coordinating the operational programmes**. These recommendations should include the parameters with which individual calls for proposals should be launched in order to be attractive to the relevant target groups while meeting the objectives of the National Roadmap. The recommendation is also to **launch more calls at regular predefined intervals so that they are predictable for the target groups** and so that interested parties can prepare their projects well.

When financing courses with participants' or companies' own funds, it is necessary to focus on the motivation why participants or companies should want to do it. This step is very much related to awareness-raising about, for example, incoming legislation from the EU - for example, a publicly funded awareness-raising measure can motivate participants and provide them with enough information about future obligations that they are then motivated to pay for more detailed courses from their own resources.

Format and clarity of the National Roadmap

The document should be clearly formulated and easy to understand even for a person who only comes across the National Roadmap without further context. It is therefore necessary to **emphasise the project's focus on construction education in the title and in the text and to clearly define the target groups**. It is recommended to provide a suitable **short title for the document in both Czech and English**, which includes the key words of the area: not the generic

"National Roadmap", but for example "National Roadmap for Education in Construction" or a similar alternative after discussion in the project team. The name should be understandable for all target groups. This title should be used consistently throughout the text for the reader's understanding.

At the same time, the document should be provided with in**teractive links that refer directly to the documents or resources mentioned**. It is also necessary to focus on **graphic quality and clarity** to make the document attractive and understandable for readers outside the academic environment - for example, representatives of companies or consultancies who are also part of the system change. The National Roadmap of Croatia, for example, can be an inspiration for clarity. At the beginning of the project, it is necessary to have a brief executive summary of optimally 1-2 pages.

Promotion of the National Roadmap and institutional cooperation

Already in the development of the National Roadmap it is necessary to involve all relevant institutions that are listed as responsible or cooperating in the identified measures. **Once completed, the National Roadmap needs to be further disseminated and promoted, both among partner institutions, ministries and public institutions, and among the wider professional public: companies, consultancies, NGOs, universities, schools and others**. It is through the involvement of all these stakeholders that the systemic change targeted by the National Roadmap can take place.

7. Skill gaps between the current situation and the needs by 2030

7.1. Forecasting construction needs in 2030 and beyond

7.1.1. Overall characteristics

Over the last 30 years, the Czech construction sector has undergone major changes. During this time, one third of the buildings that make up our current housing stock have been built. A significant part of the older buildings has been modernized, rebuilt or renovated. The construction was often very extensive, especially the development of housing in the villages surrounding large cities, but also in the construction of industrial complexes along transport routes, which meant unnecessary seizure of agricultural land and costs for engineering and transport equipment in the area. The densification of the built-up area, coupled with the revitalization of abandoned industrial sites, was another area that brought a number of discussions about scale and appropriate form. New transport routes, particularly for road and rail, offered new connections, but also changed the layout and operations in many communities. In recent years, new demands have been placed on the form, quality and sustainability of construction. Demands for architecture and building culture, for energy efficiency, for carbon-free economy, for waste management and for recyclability of materials have been formulated. The emerging phenomenon of the times is digitalization and Construction 4.0.

In this context, the European Union has announced a "renovation wave" that should increase the level of construction effort in renovating existing buildings and adapting them to new requirements by up to 2-3 times. This entails new strategic changes over the next five years, but also beyond 2030 until 2050.

New questions are raised. Many decisions will require a rethinking of the question of resources, not only energy, but also material and human resources. The construction industry has always been local, linked to local resources: bricks, stone, wood, glass, cement and their transport. The construction industry has always employed a significant proportion of less skilled workers, but is currently facing a growing shortage of craftsmen and manual workers in general. How will this situation be affected by the rise of artificial intelligence (AI) and robotization, particularly in the "renovation wave"? The solution to these questions is not only technical, but increasingly social and economic.

The size and ownership structure of companies in the construction sector has its own specific features, which significantly affect the current and future conditions. On the **investor side**, roughly half of the investors are state and public investors (construction of roads, railways,

military buildings, municipal buildings: schools, hospitals, social institutions, public space care, etc.). The other part is represented by large developers (both Czech and foreign), who build apartment buildings, or various production warehouses and other ground constructions, or are involved in energy construction and engineering networks. A large part of small investors are builders of family houses and small businesses, where there is often a lack of systemic support and expertise for such activities.

The designers are usually recruited from Czech companies, or if they are from abroad, they rely on cooperation with Czech entities. This is additionally conditioned by the law on authorization of persons and membership in ČKAIT or CCA (ČKA).

The manufacturers and production plants are largely in the hands of foreign companies (producers of mortar, glass, bricks, concrete, wood products, prefabricated products) and only additionally are domestically owned. This is reflected on the one hand, in the dependence on research and innovation from foreign parent companies; on the other hand, progress is relatively quickly imported into the Czech Republic, or the Czech contribution is quickly exportable.

The supply capacities are provided by large construction companies, which are, with a few exceptions, Czech subsidiaries of foreign concerns, which limit their activities to the Czech Republic or the nearest region. Only rarely they are invited to the parent organizations to supplement the foreign supply capacity (the percentage of export varies from 2 - 4% of the Czech capacity). This is again reflected in the fact that development and research work in the Czech Republic is rather complementary, but these firms can relatively quickly draw on the international know-how of their parent companies. However, most of these companies are far from employing all professions and ensure the implementation of the construction with the help of a whole group of subcontractors from smaller specialized companies (often Czech), or by directly hiring specific craftsmen. This also applies to the employment, often by agencies, of foreign workers. This system allows for a relatively flexible response to specific professional needs and capacity utilization of the experts available, and fluctuations in the stability of investment funds going into the construction sector. However, it is also an escape from legal employment complexity, particularly for seasonal work. Smaller specialized firms and individual craftsmen thus balance the campaigning nature of construction work in different ways. A large part of these capacities is devoted to renovation and construction of "self-help" buildings and often form part of the informal economy.

Builders and professional Facility Managers represent a professionally very heterogeneous mix. Small private property owners (builders of family houses, cottages and the like), usually stand completely outside their expertise in this function. Municipal buildings, developers' buildings, rental buildings, and buildings for large companies have professional managers who

take care of cleaning, maintenance, repairs, paying property taxes and fees, etc. Their ties to the building professions are very diverse.

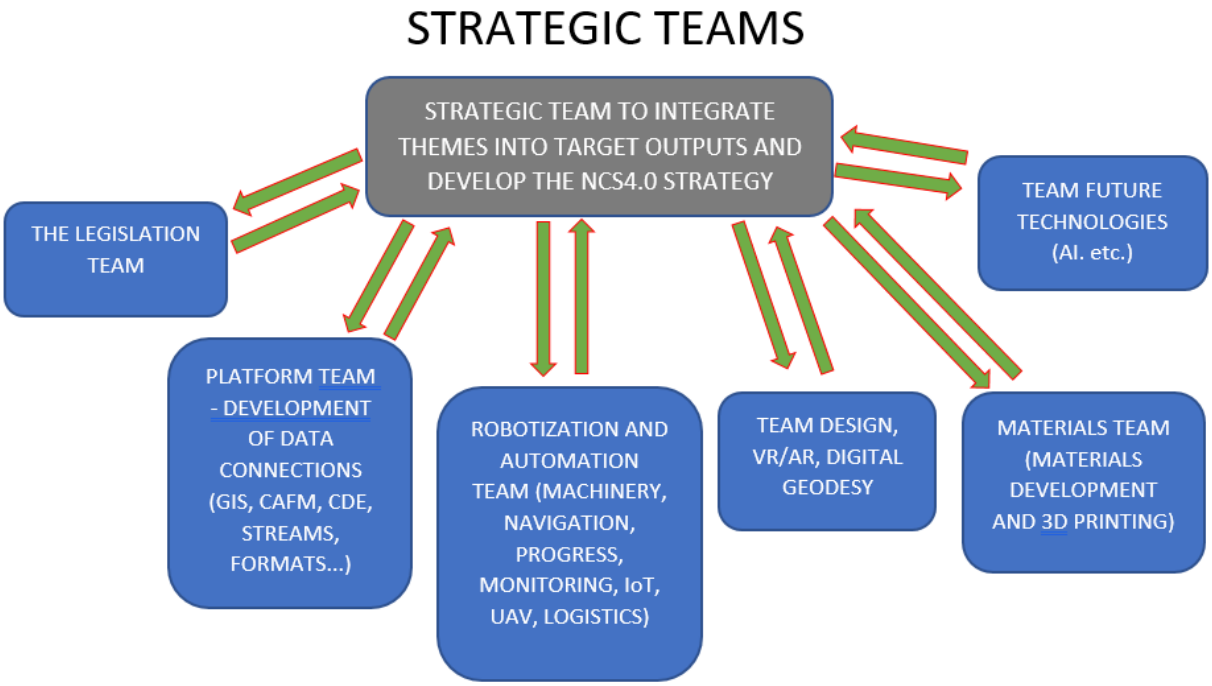
7.1.2. Digitalization and artificial intelligence

Digitalization is undoubtedly the biggest change in the construction sector in the last 5 years and the Covid has further accelerated it. The Digital Act regulates the rights and obligations of the citizen and the state, and digital communication has become a universally accepted form of communication, not only for children. The design preparation of buildings is now almost exclusively in the form of digitization of all drawings and visual plans. The process of digitalization of the state is open, but its implementation and its application in the process of preparation of construction and management of public buildings is advancing more slowly and with a number of problems. Nevertheless, BIM (Building information modeling) is already changing to Building information management and the Building Information Model is becoming a tool that not only contains the 3D digital twin of the building but is also a place of common storage and communication with all the data (even textual) of the various construction partners. The experiences of the individual, so far mostly private, companies and users stand side by side. The nationwide concept lies between a non-binding methodology and the pursuit of "total digitalization" with a daunting task: to build standardization and contractual standard on processes that are still emerging. There is a big task in education of all users in the transition period, the fulfilment of which will condition any progress in this area.

The discussion initiated in 2017 at the Foundation for the Development of Architecture and Construction brought about the "Memorandum for the creation of the Construction 4.0 platform" in 2021, signed by the Ministry of Industry and Trade, the ABF Foundation, the Association of Construction Entrepreneurs, the Czech Institute of Informatics, Robotics and Cybernetics CTU, the Technology Agency of the Czech Republic, the companies Hochtief, Metrostav, Bouygues Construction Group, Baumit and the construction faculties of CTU, VUT and VSB-TUO. The platform was given a solid form on 18 January 2022 upon the signing of the contract on the National Centre for Construction 4.0, which has so far been joined by 35 organizations: construction companies, design companies, manufacturers of building materials, non-profit organizations, universities and even representatives of the state administration, who regularly participate in the meetings.

The result of this effort is the formation of teams composed of representatives of manufacturing and supply companies, design and academic sphere, non-profit professional sphere, as well as representatives of state and departmental organizations, which gradually form goals and tasks for individual sections of the construction sector, better perhaps construction 4.0.

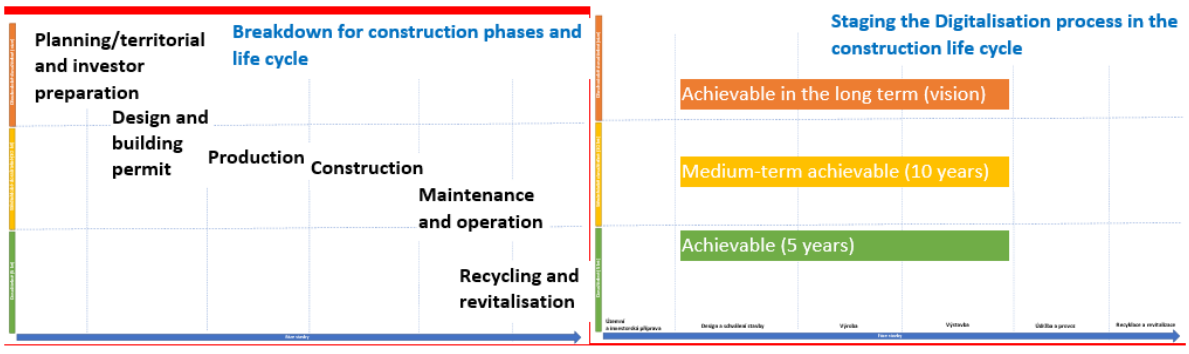
Figure 8: Strategic teams



An overview of the expected development stages, divided into three future periods, became the basic outline:

1. Achievable in a five-year perspective;
2. With a ten-year perspective;
3. As a view to 2050 monitored at all stages of the construction life cycle.

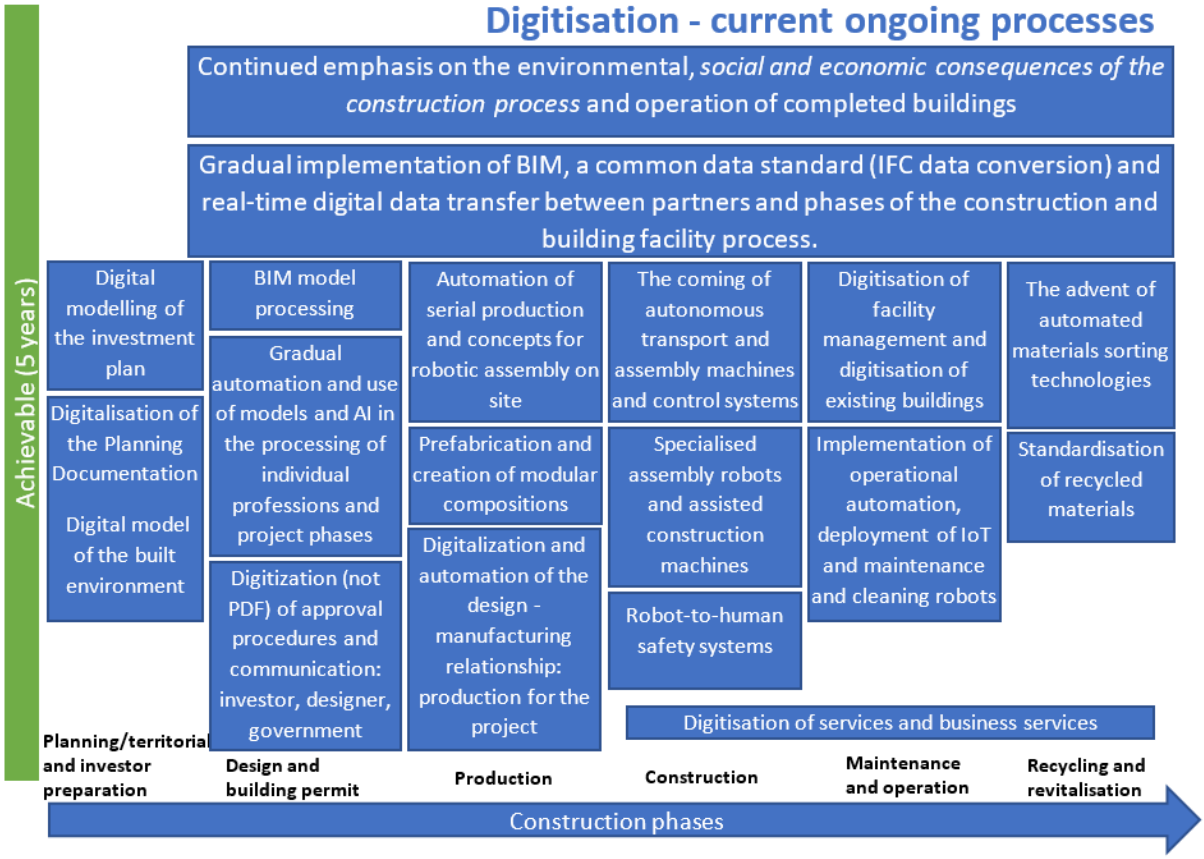
Figure 9: Stages of Building Construction 4.0.



The most thoroughly discussed was the period we are currently experiencing, of which it must be said that it is 1) potentially filled with a number of very substantial changes but 2) almost all

of the buildings that will be completed over the next 5-7 years are actually designed or at least in the pipeline today, and digitalization will often catch them in a process that has not begun as "digital".

Figure 10: Current processes of digitalization



As a cross-cutting, in many ways decisive aspect, the following requirement is formulated: **A permanent emphasis on the environmental, social and economic consequences of the construction process and the operation of completed buildings**, which includes at all stages the set of energy, social, economic, cultural, demographic and other requirements that society places on the construction industry. The second cross-cutting requirement is: **The gradual introduction of BIM, a common data standard (Industry Foundation Classes data conversion) and real-time digital data transfer between partners and phases of the construction and building management process** that reflects the current state of digitization and processes in each phase of the construction lifecycle that are currently being addressed and developed.

In the area of Spatial Planning and Investor Preparation these are**:**

- **Digital modelling of the investment plan**, i.e., the procedures used in the process of investor preparation, tools for builders in decision making and evaluation of the plan of a specific investment;
- **Digitization of the planning documents and the digital model of the built environment** that is the digitization of the state administration, land administration, regulations in the territory and the simplification of Digital Regulatory Conditions for specific buildings on specific sites.

In the field of design and building approval, these are:

- **BIM project processing**, i.e., the creation of jointly usable data models of the construction project that can be used by all other participants in the construction process;
- **Gradual automation and use of models and AI in the processing of individual professions and project phases**, many project performances are actually the elaboration of the basic architectural concept into project details (bills of quantities, budgets, but also energy loss calculations, static assessments, etc.), which are already solved today by specialized, not yet connected software tools;
- **Digitization (not PDF) of approval procedures and communication**: **Investor, designer and state administration**. This is the biggest challenge for the transformation of the state administration and the still rather partially secured legislative framework of the approval process, full of unnecessary duplications, formalities, corruption pressures and biases.

In the field of building products manufacturing these are:

- **Automation of serial production and concepts for robotic assembly on site**. The automation and robotization of the manufacture of building products follows the trend of Industry 4.0 and represents the most progressive part of the process under study. Its current data isolation from other processes and the relatively limited Czech market are still a barrier to its further effectiveness;
- **Prefabrication and the creation of modular compositions**, the return to elemental and volumetric (now modular) typification of building parts, was long hampered by the bad experience with typification in the 1970s and 1980s with the construction of housing estates with a limit of manufactured elements and the "greyness" of the built environment. Today, however, the new digital lines offer individual production for each element, but this requires a completely different project preparation of the building, which envisages such technology from the outset, and a different equipment of the contractor–assembler of the construction is required;

- **Digitalization and automation of the design – production relationship: production for a project** is a natural requirement, which so far encounters a number of legal (Public Procurement Act versus the project processing phase under the Construction Act), organizational, standardization and yes, especially knowledge conditions. The workers of one phase will be able to optimize and use the offers and conditions of another now isolated phase of preparation and implementation of the construction.

The construction, the actual implementation of the building, emphasizes in particular:

- **The digitalization of services and business services and the transfer of data**, especially project data for the preparation of the contract and its management, as well as data for the supply of the construction and the coordination of subcontractors and then implementation data for the investor's inspection of the work already carried out are a great area for time and cost savings;
- **The rise of autonomous transport and assembly machines and control systems** is the way to improve supply, assembly of modular ready-to-assemble components and parts;
- **Specialized assembly robots and assisted construction machines** are robots that are already replacing the hardest construction work, but also printers of building structures and components on site;
- **In fact, robot-human safety systems** are new requirements that are consistently addressed in Industry 4.0 robotic manufacturing spaces, where robot work areas are strictly separated from human areas. These on-site requirements bring a whole new category of requirements for measures, training of staff, but also limitations of traditional practices.

Maintenance and operation:

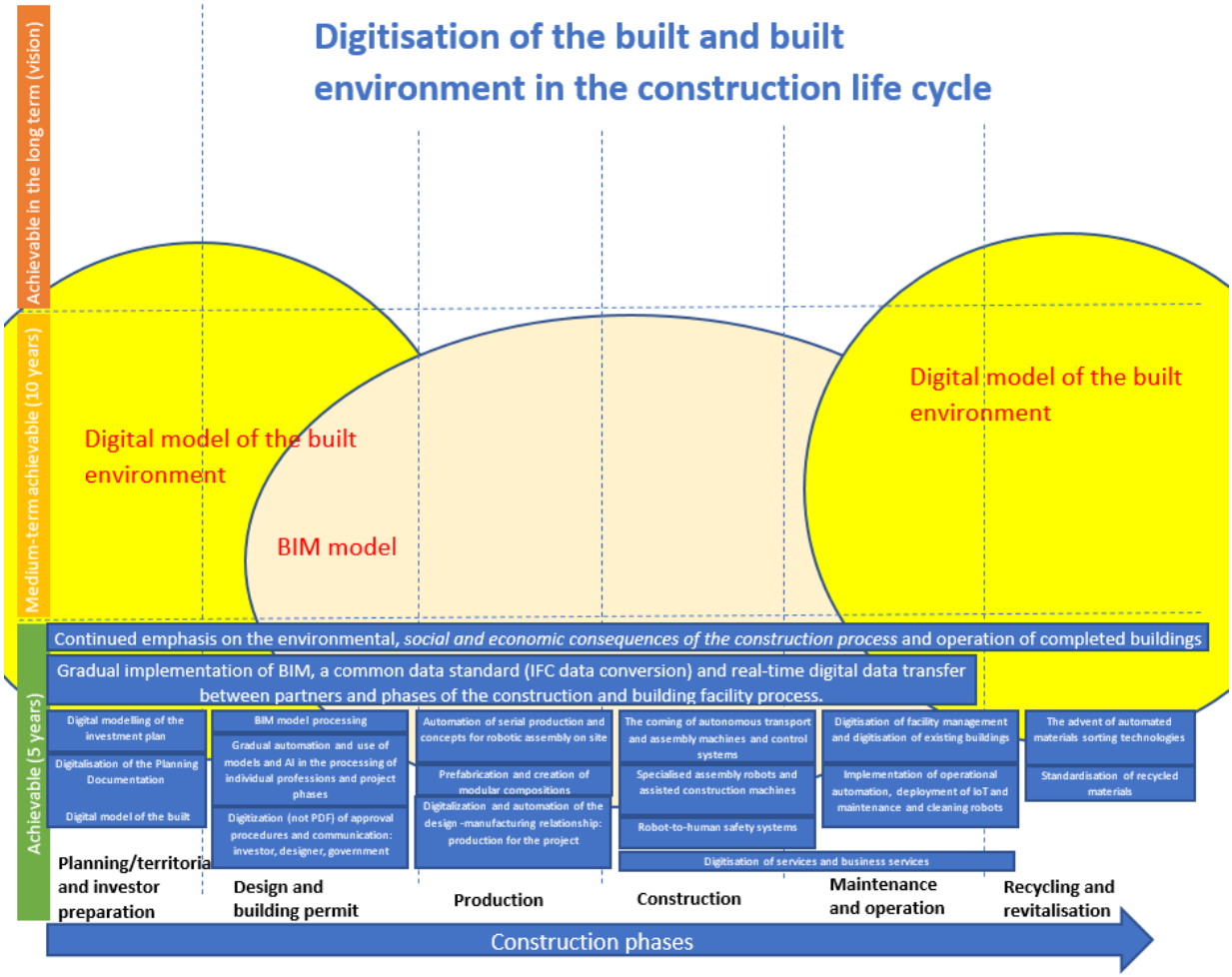
- The digitalization of construction management, and the digitalization of existing buildings actually redefines the challenges for the Facility Management profession, for which it is a tool for significant simplification and improvement of performance (replacing stacks and cabinets of documentation with automated processing of data provided on a timely basis). For the renovation wave, the processing of digital documentation of existing houses that either do not have documentation or it is incomplete (which will greatly hinder the renovation preparation work) is of crucial importance;
- The introduction of automation of operation, deployment of IoT and maintenance and cleaning robots is in fact a new challenge that poses the question of the different lifecycle of IoT components, which have an innovation cycle of years (including the

services provided), and the lifecycle of most building structures and products, which have a lifecycle of decades and even centuries.

Recycling and revitalization:

- The advent of automated material sorting technologies is gradually making its way into building demolition, replacing asphalt road "carpeting" and elsewhere. There is a way to go directly on-site or in specialized sorting plants for selected fragments of construction waste;
- In fact, standardization of recycled materials is a new problem, as most building products and materials are strictly regulated by standards and testing that rely on standardized input of basic raw materials. This assumption often cannot be met in the case of recycling, and the issuance of the appropriate certificate on the composition and quality of the recycled mixture for the time being, somewhat limits their usability.

Figure 11: Digitalization of the construction



The scope of the ongoing strategic changes described above, which will gradually affect the entire construction sector in the near future, is strategically directed towards two national goals:

1. **Use of BIM model for the entire construction life cycle**, for data transfer between partners, for remote collaboration, for streamlining, shortening and improving the entire construction process and construction care. Nevertheless, this goal will also increase the work load during some project phases, the need for updates of data from the construction and operation process and finding common data standards for all participants, which is a condition for their voluntary involvement in the BIM system. This may require widely varying responsiveness among participants and the need for a new redistribution of tasks and responsibilities among partners. If Construction 4.0 is to be a revolution in the construction process, it must bring significant social and economic benefits, and it cannot

be done without the loss of many professions, the creation of new ones, the setting up of new roles and the redistribution of responsibilities between them.

2. **Setting of a digital model of the built environment,** which will gradually include digital information about the entire territory (cadastral data, digital technical map, landscape and geological conditions, social and economic data, data on traffic loads, air flow, and current data on the state and operation of the territory; it will also include spatial analytical documents, digital spatial planning documentation, spatial planning documents and various pending land use and investment plans). Gradually, this model will be filled with BIM models of individual buildings, either from upcoming and new buildings, or as a result of the digitization of existing buildings for the needs of facility management and the upcoming renovation wave. It can be assumed that the implementation of this model and its dynamic use by all construction partners is a task that will not be achieved in the first phase by the end of 2030. However, its establishment and perhaps legal anchoring in the forthcoming BIM Act should provide a framework for its gradual establishment. The path to this model will probably be influenced a few more times by new technical possibilities, but also by the requirements for the specific use of already processed datasets.

7.1.3. New roles for the workforce

The current crossroads at which the Czech construction sector finds itself (see above) greatly complicates the possibility of **accurately estimating** the requirements for the construction workforce, both in terms of numbers and skill structure. Indeed, the persistent shortage of workforce in the Czech construction sector, due to the low attractiveness of it (both in terms of remuneration and working environment) in competition with other sectors, can only be solved by digitalization of the construction sector, or the introduction of other modern technical and technological changes in the process of preparation, construction and management of buildings and networks. This modernization, which is also closely related to the requirement for energy-efficient construction, therefore places completely new demands on the number and qualification of the workforce, and therefore also on their education. It is, nevertheless, difficult to articulate (and quantify) these requirements, as they are still rather theoretically suspected and are currently mentioned only marginally by construction companies and investors alike. The "pressure from below" is thus mainly in the demand for **traditional construction professions**, as can be seen from the survey on the needs of the construction sector (see chapter 7.2.)

This call "from below" has a rational core. In the Czech conditions, there is indeed a long-term shortage of craft professions, ageing of workers and a slow "inflow" of craftsmen from primary education institutions. The solution may lie in increasing the proportion of retrained workers

and those entering craft roles using sophisticated technologies and increasingly demanding techniques as technical progress increases.

Even so, construction in the Czech Republic will not be able to do without additional sources of craft professions by 2030. Ensuring sufficient numbers of craftsmen has a strategic aspect as well: the requirements for increased renovation of the existing housing stock (including listed buildings), together with the requirements for increased energy efficiency of renovated buildings, will continue to place great demands on quality craftsmanship in the future, and thus on the number and especially the quality (or appropriate structure) of craftsmen in the construction industry.

7.1.4. Estimates of the requirements for individual professions and the way they are trained

In terms of the total scope of employment in the construction sector in 2030, it will certainly not experience major changes compared to today. This is reflected both in demographic development, with its insignificant effects on the extent of labour supply in the labour market in general, and in the considerable rigidity in the development of social and economic factors affecting the attractiveness of working in construction.

Therefore, if the total number of workers in the construction sector is currently (2020) 402.2 thousand workers[33], even in a relatively optimistic scenario, an **increase to 405 thousand workers** can be expected in 2030. This would be an **increase of only 0.6%!**

At the same time, some **quantitative shifts within the structure of total employment** can be expected in this optimistic scenario, especially to improve the ratio between "executive" and "staff" workers. The number of people involved in one way or another in the management of construction production is currently 154.7 thousand; for 2030, the number can be estimated at 152.5 thousand, that is, 2.2 thousand less (- 1.5%). By contrast, the category of construction workers could and should grow from 186.7 thousand by 3.8 thousand (+2.1%) to a total of 190.5 thousand. In the "assemblers" category, the boost should be even more noticeable, from 30.6 thousand to 31.8 thousand (+ 1.2 thousand, i.e. + 4.0%).

Realistically, therefore, we can expect a **maximum of 5,000 more people in craft occupations by 2030**. It is obvious that such a small change would be completely inadequate to the newly emerging demands for energy-efficient and technologically modernized construction in the

[33] The 'EU 2020 Labour Force Survey', implemented by CEDEFOP

Czech Republic. The solution can only lie in shifts between occupations, i.e. that employment will fall in some craft occupations in order to grow in others. An overall overview is given below:

1. **MBP bricklayer (main building production).** The versatile profession of bricklayer is experiencing considerable changes. The original profession included tile setters, plasterers, stucco workers, wall systems installers and, most recently, insulation systems installers. A good bricklayer can actually do a bit of all the building trades. At the same time, these sub-masonry professions have their own separate professional guilds (Guild of Tilers, Guild for Insulation of Buildings, etc.) and are deployed at various stages of building construction. In the process of the main construction production, bricklayers, together with other professions, ensure the implementation of foundations, vertical load-bearing and horizontal structures. There are two development tendencies at this stage of construction: one is towards a variety of different walling materials (brick, blocks, masonry blocks) and the proportion of prefabricated concrete, steel and timber structures is gradually evolving. Traditional walling materials are supplied in a series of assembled hollow concrete blocks, are adapted to seamless walling and some have integrated thermal insulation. Different variants of walling materials require different masonry technologies and subsequent material compositions in their final surface treatment. The second tendency is the demand for precision and the requirement to brick up all penetrations, grooves, and passages in the basic construction without the traditional subsequent cutting of grooves for the conduction of medical wiring, heating or wiring. This requires following the project and not building by memory as walling used to be performed. The conditions for coordinating the trades must be established at the inception of the basic structure. Further requirements for specialization and precision can be expected and thus the profession's expertise can grow. Increasing productivity should tend to produce a lower number of better prepared bricklayers. This cannot be done without the digitization of projects and the ability of bricklayers to carry them out according to detailed digital documents. This approach also opens up space for the gradual introduction of bricklaying robots into the process.

2. **Concrete and steel erector** is a profession that has separated from the traditional bricklayer with the development of prefabricated buildings and the development of prefabricated steel structures. The erector is much more dependent on the precise technology of a given assembly. The assembly can be used for foundations, structural walls and horizontal structures. The boundary between the knowledge and skills of the bricklayer on the one hand, and the locksmith and welder on the other for steel buildings, represents the range of skills required. The applied energy efficiency requirements must already be included in the prefabrication and assembly

instructions, and the actual assembler must be instructed in particular on the necessary coordination and purpose of the modifications to the system to be assembled. On the whole, a slight decline in demand can be expected in this specialization. This area, too, is subject to rapid digitalization, which is a prerequisite for both the rationalized production of these components and parts of buildings and their robotization during assembly. This will also require changes to the structure and scope of project documentation.

3. **Concrete and iron work** are professions that arose from the specialization of masonry with the development of monolithic concrete. The erection of formwork, execution of reinforcement, iron work and pouring of concrete entails the work of an erector/assembler, carpenter and joiner, locksmith and welder, concrete worker. If a monolith is used for some structures, no significant change in working practices can be expected, there will probably be additional demands for accuracy and implementation of all penetrations and sub-modifications already at the basic structure stage, and there will be a requirement to address thermal bridges for structures that are expected to pass through spaces of different temperature standards. For other professions, even reinforced concrete workers create the basic skeleton of the house, which will either facilitate or dramatically complicate the work of other professions. Given the anticipated use of monolith, a slight decline in demand can be expected for the profession. The 3D printing of buildings is setting completely new requirements, and, from the first experiments, it is beginning to make its way into commercially viable building projects, continuing the traditional concrete concept of building construction.

4. **Plasterboarders, drywall installers and timber structure installers** form an important group of professions that are heavily involved in efforts to create the conditions for a desirable energy standard in buildings. Even these professions are divided into several separate guilds; The Guild of Dry Construction in the Czech Republic, the Association for the Construction of Prefabricated Wooden Houses, etc. These associations, in cooperation with manufacturers, intensively prepare a set of necessary knowledge, skills and requirements for their members. These relate to individual technologies and their application in construction. In the 2030 horizon, this will be sufficient to maintain qualifications, but it is desirable to increase capacity for these professions in primary education. This field is an example of the emergence of a new profession in the past 30 years, as plasterboard technology only started to establish itself in the country in the early 1990s.

5. Machinist, machine operator, crane operator, driver, scaffolder. These are professions – services that do not directly affect the character (including energy efficiency) of a

building by their activities but are undoubtedly important for creating conditions for other professions. Within the timeframe in question, they will be adapting to major changes in construction procedures and requirements for coordination of supply and time deployment of technical support for other professions. Overall, the quantitative need for these professions will be stable at the current level.

6. **Insulation worker, insulation against moisture, against chemical influences, roof insulation.** A significant contribution is made to the system of the building envelope. The implementation of the individual insulation layers in the case of a stacked wall envelope, in the roof design, or in the protection of the building against ground moisture and groundwater, always depends on the overall composition and materials used in the other layers, on the position of thermal insulation, on its absorption, on the protection against the more adverse influences, and on the method of moisture control in the various modes of the building interior. Careful installation of the insulation (of the substructure, the external walls, the roof and any separation of individual spaces within the building) must always be addressed in a complex manner. It is the spaces of energy-efficient houses with heat recovery, for example, that bring radically new requirements in terms of the knowledge of the relevant staff as well as the method and quality of execution of these types of insulation. In sandwich constructions, the scope of labour is therefore likely to increase, but this trend will probably be balanced by the increase in productivity and complexity of the insulation systems used and will be incorporated into the work of a sandwich wall, floor and ceiling (roof) structures installers. In summary, the need for these workers in the labour market can be expected to stagnate.

7. **Plumber, installer of healthcare technical systems and equipment** provides work associated with the distribution of water, sewerage and gas, ensures the installation of furnishing items and hot water distribution. Specialized work is then carried out by workers with special certificates: gas equipment and systems technician, gas equipment mechanic, who provide installation and inspections before commissioning and during regular annual inspections. The Guild of Plumbers of the Czech Republic strives for the qualitative development of this profession, as do other companies: the Czech Association for Technical Equipment, the Czech Gas Association, the Association of Technical Equipment Entrepreneurs of the Czech Republic. These professions are making a major contribution to the new concept of energy-efficient construction. In particular, this concerns the method of pipe routing and insulation of distribution systems against heat loss, the methods of penetrating structures while maintaining their impermeability, and the choice and installation of environmentally friendly appliances and equipment. Coordination of work with other professions is becoming

increasingly challenging and more important, as is the adaptation to BIM. On the whole, the current level of demand for these craftsmen can be expected, but for "better" craftsmen. Achieving the implementation of the indoor environmental quality requirements is a challenge, particularly for the planned refurbishment programme where new technologies and equipment will be applied to historic structures.

8. **Plumber – heating engineer** provides hot water distribution, installation of heaters and installation of heating and domestic water heating equipment. This profession came into being through a gradual separation from the general plumber and its development is being taken care of by the Association of Heating Engineering Companies, the Guild of Heating Engineers and Plumbers of the Czech Republic and the Heating Association of the Czech Republic, which develops central heat sources, their distribution, heat exchangers and related distribution in houses. Technical progress in material and technological variants of heat distribution, in heating methods, in the transition to low-temperature heating, the move away from traditional heaters, methods of regulation, variants of heat sources based on various alternatives of renewable energy sources, as well as the process of transition from district heating sources indicate the scope and dynamics of this profession, which every year has to respond to the updated offer from the industry and the growing requirements of efficiency and performance of the built and renovated heating systems of buildings. With the application of the thermally insulating protection of the envelope and the requirements for heat recovery, many of the traditional practices and principles applied by the profession are fundamentally changing. This will have to be accompanied by quite significant changes in the training of these professionals (both in primary and lifelong learning), however, given the significant opportunities for labour productivity growth in the sector, we can expect a significant drop in demand for them.

9. **Stove fitter, chimney sweep** are traditional professions, providing heating in local heating systems. An important element of this work is ensuring the conditions for fire safety in buildings. The application of renewable sources means once again reinforcing the significance of these professions. Similarly, many renovations of existing houses continue to use local heating systems. The professional development is provided by the Guild of Stove Fitters of the Czech Republic and the Association of Chimney Sweeps of the Czech Republic. The new requirements for energy-efficient construction will naturally have a significant impact on these professions as well, since the requirement for the thermal performance of individual devices will decrease with good insulation, while the issue of the amount of CO_2 in the room, as well as the requirements for the airtightness of rooms equipped with heat recovery, will probably call for systemic

changes in the application of heaters, their location, equipment and operation. In general, we can expect this profession to develop in the foreseeable future in roughly the same way as plumbers and heating engineers, i.e. an absolute decline in demand with increasing requirements for professionalism.

10. **Carpenter, assembler of wooden structures for wooden buildings.** Carpentry work is traditionally associated with the construction of roofs, which is why it is embraced by the Guild of Tinsmiths, Roofers and Carpenters of the Czech Republic, which actually brings together three separate professions involved in the construction of a classic roof. However, with the development of wooden buildings, this profession is now also involved in the overall construction of the basic structure of the house (included in the MBP – main building production). In both cases, the carpenter is involved in the construction of the roof or even the wall and floor part of the building envelope, thus fully contributing to the concept of an energy-efficient house. In addition to the traditional knowledge of the basic material, timber, new requirements are introduced for the functioning of various composed structures in terms of their interaction, the creation of vapour permeable and airtight barriers in structures, the creation of a stable climate in the interior with the preservation of humidity and CO_2 values. These new aspects of the work also entail requirements for the protection of the timber used against drying out, moisture, mould, etc., which will ensure the durability of the constructions. A slight quantitative increase in demand on the labour market can be expected for this profession, but with considerable qualitative changes in the profession.

11. **Roofer, hard roofing installation.** Roofer is the third traditional profession involved in the construction of roofing composed of tiles. For tin roofs, this profession is replaced by the tinsmith and for flat coated roofs by some of the insulation workers. Even the concept of the traditional roof is changing fundamentally. Roofing has become part of a sandwich construction for most roofs, ensuring thermal comfort in the roof space, and the issues of its composition, ventilation of supplementary insulation, maintenance, passage solutions and the offer of manufacturers who supply complete systems including various (concrete) blocks and additional components place new demands on the profession, although, given the above, an absolute decline in demand for the profession can be expected in the future on the labour market.

12. **Plumber/Tinsmith** provides roofing accessories, gutters, eaves, valleys and full metal roofing. The work boundaries of the tinsmith and roofer overlap to a large extent on site for prefabricated, pre-engineered systems. Therefore, the requirements for roof design and their effect on the overall building envelope as described for the carpenter and roofer also apply to the tinsmith, with the exception, perhaps, of greater

involvement of this profession in the renovation program. In summary, a stagnation of demand on the labour market can be expected here.

13. **Construction carpenter/joiner.** A construction joiner, today more commonly known as a building fillings fitter, is responsible for the manufacture and installation of windows and doors. These products, including the work of glaziers, have now been almost entirely transferred to factory production, and, in addition, a part of traditional timber construction is being replaced by plastic or metal frames. Nevertheless, the correct fitting of openings, especially those forming part of the building envelope, is a prerequisite for achieving the effect of building insulation. Defects occur in the manufacturing process as well as in the actual installation and positioning of the window in the wall and its sealing. An energy-efficient building must have (in both new constructions and renovations) excellently designed and installed filling of external openings. Even the design of internal doors will change with the installation of heat recovery systems, which the installer must be aware of and respect the concept of the physics of the interior space and the precise installation of the products he provides. The content of the education of these professionals will therefore have to undergo a qualitative change and an increase in training capacities will be desirable, too.

14. **The locksmith,** as a profession that works with metal, has several roles during the construction process. He is involved in the installation of the basic metal structure (although this is usually provided by a specialized installer of the steel structure supplier), he is present during the installation of additional metal structures (windows, greenhouses, elevator shafts, supporting structures for various technical equipment and for interior furnishings, etc.), he provides railings and fencing. The locksmith cooperates with the welder. Similarly, to the joiner, the locksmith enters the construction processes and provides the structures that are directly related to the design and execution of the building envelope, in this sense he contributes significantly to the conditions for meeting its required energy values. However, on the whole, we can expect a stagnation in demand for this profession on the labour market.

15. **Flooring installer,** the flooring profession is often divided into a number of sub-specializations according to the material and technology involved. The suitability of the chosen material and its correct execution is often crucial given the energy requirements for houses and their heating methods. The correct installation of the individual subfloor layers, issues of moisture and water vapour penetration, the possibility of underfloor heating and other floor properties have an impact on the overall composition and their correct use and precise performance is often a stumbling block even when using quality materials. In this profession, it will be particularly necessary to prepare appropriate technical and technological "data sheets" -

procedures for their use - in cooperation with the individual manufacturers. On the whole, stagnation in demand on the labour market is to be expected here as well.

16. **Painter, varnisher, paper hanger.** These three traditional professions are associated in the Guild of Painters and Varnishers of the Czech Republic. The final impression of a completed or renovated building depends on their work. In principle, however, a quantitative stagnation in demand can be expected.

17. **Bricklayer in the associated construction production (ACP)** – is involved in a number of relatively separate work phases in the ACP, for which sub-occupations are created. Most recently, it is, for example, a thermal insulation installer who provides the entire thermal insulation system, including the final plastering. New materials with a higher insulation value (vacuum insulation, etc.) are constantly putting pressure on the desired innovation process, to which the practice must adapt. Certain technological processes require a separate professional approach, an example being the use of roof insulation with polyurethane foam, which creates its own professional professions. The traditional plasterer and stucco worker, therefore, abandon some previously used practices for exterior plastering. In the case of interior plastering, we can observe similar requirements as we have defined for the painting and varnishing profession. A separate specialization is the repair and restoration of historic buildings. In view of the latter, a slight increase in labour market demand can be expected for this profession. The same applies to other occupations that have been separated from bricklaying, such as tile setters and stonemasons.

18. **High voltage electrician.** The work of electricians is significantly complicated due to the requirements for the physical and structural properties of walls, especially in their sandwich arrangement. Electrical wire routing and penetrations through structures shall be determined and arranged in advance or shall be placed in structures in such a manner as not to impair their airtightness or cause thermal bridging or disruption of layers providing moisture conditions of structures or spaces. It is naturally an architectural requirement to conceal these ducts. The solution is coordination in the project and on site with other professions (BIM). Minimizing the consumption for operation, new lighting methods, the positioning and selection of lighting fixtures are new tasks for the profession. On the whole, however, demand for this profession can be expected to stagnate at the current level.

19. **Electrician of low-voltage distribution systems.** We can no longer imagine efficient house operation without smart control of heating, ventilation and lighting or shading. The operation of facilities using renewable energy sources, the use of solar and wind energy, the use of geothermal heat, as well as the economical operation of a wide

range of appliances depend on measurement and control systems. Complex smart home systems are increasingly prominent on the market. In this sense, the profession is of high expertise and narrowly specialized. However, for the final effectiveness of energy efficiency measures in buildings, it is crucial from an operational point of view, both for new buildings and renovations. The second similar group is security systems. The issue of home security encompasses a whole range of measures, products and technologies: shatterproof glass, secure locks, property fencing, etc., but the basis are electronic security systems, camera systems, etc., connected to the smart home system and security centres. Finally, the traditional low-voltage distribution systems: antenna wiring, bells, telephone and the internet running over its lines present a similar problem to the high voltage wiring in terms of their routing and location on and in the structures. In summary, this profession can be expected to see a dynamic increase in demand on the labour market.

20. **Air conditioning, installation of air conditioning equipment.** The installation, assembly and cleaning of air ducts, filters and air conditioning and heat recovery units is one of the professions that will see the greatest growth, especially in residential buildings where it has been used only rarely. This is the case, for example, with heat recovery and air conditioning equipment for an energy-efficient house. It can also be expected that, as with gas boiler inspections, the need for hygienic inspections and the need for professional cleaning of installed air ducts will increase. In comparison to the present, the demands on the profession will undoubtedly increase both in terms of quality and quantity.

21. **Installer of other equipment.** Installation of other equipment includes specialized occupations for the installation of: pumps, compressors, water management equipment, transport equipment (lifts and escalators) and other equipment. Each of these specializations relies on specific applications of industrial products for equipment that is intended to be permanently integrated into a building. Some of these directly condition or develop the energy-saving functions of the house (e.g. heat pumps), while others provide traditional services (lifts). The installation of these devices in newly designed and renovated spaces of passive houses has many features in common with the installation of air conditioning equipment and other technical distribution systems. The training of these professions is primarily dependent on the specific manufacturer; from the construction point of view, the ability to coordinate (BIM) plays a major role. Overall, a slight increase in the need for people with this specialization can be expected.

22. **The installer of building envelopes** is in fact a new professional field established by the market and focusing on complete services with the supply and installation of

window panels, doors and lightweight building envelopes, which is represented by the independent Czech Chamber of Lightweight Building Envelopes. Its importance has grown especially in the process of requirements for insulation in the implementation of the building envelope.

23. **The solar installer**, the installation of home power plants, the replacement of traditional heating systems with heat pumps, home battery stations and electric car charging systems form a set of activities that are gradually transforming a number of professions (plumber, electrician, heating engineer and others) into a new complete service, a new specialization. The Solar Association – the association is currently aiming to link these activities and create the conditions for the professional fulfilment of this new requirement of individual investors.

Table 25: Quantitative requirements for individual crafts and the level of innovation in their training by 2030

No.	Crafts	Expected growth or decline by 2030	Innovation rate of knowledge and skills of professions by 2030
	MBP		
1	MBP Bricklayer	slight decline	system innovations
2	Erector of concrete and steel structures	slight decline	partial innovations
3	Concrete and iron work	slight decline	partial innovations
4	Plasterers, dry installation (without wood)	slight increase	system innovations
5	Machinist, machine operator, crane operator, scaffolder, driver	stable number	
	ACP (Auxiliary construction production)		
6	Insulation worker, waterproofing, roof insulation	stable number	partial innovations
7	Plumber, water, sewerage, gas	stable number	system innovations
8	Plumber-heating engineer	decline	system innovations
9	Stove maker and chimney sweep	decline	system innovations
10	Carpenter and assembler of wooden structures	slight increase	system innovations
11	Roofer	decline	partial innovations
12	Tinsmith	stable number	partial innovations
13	Construction joiner	slight increase	system innovations
14	Locksmith	stable number	partial innovations

15	Flooring installer	stable number	partial innovations
16	Painter, varnisher, paperhanger	stable number	partial innovations
17	ACP Bricklayer: thermal insulation, plastering,stucco, tile setters, stonemasons	slight increase	system innovations
	Mcen		
18	High-voltage electrician	stable number	partial innovations
19	Low-voltage electrician	huge increase	partial innovations
20	Air conditioning technician	huge increase	system innovations
21	Installer of other equipment	slight increase	
22	Building envelope installer	huge increase	partial innovations
23	Solar panel installer	huge increase	system innovations
24	Heat pump installer	huge increase	system innovations
25	Construction equipment operator	huge increase	system innovations
26	Green element installer	huge increase	system innovations

Wherever the description of the development of individual professions refers to the need for "systemic changes", it responds to the results of the research "**Competence 4.0 Project**" elaborated by Trexima, spol. s r.o. for the Ministry of Labour and Social Affairs of the Czech Republic (2022), which dealt with the mapping of future competences as part of systemic measures for defining the requirements of the labour market ("Competence 4.0") and which also touched on some areas of the construction industry. In terms of the skills needed, the research underlined the **cardinal importance of the penetration of digitalization** in most professions involved in the preparation of approval, design, implementation of construction and its supply with building products, as well as professions involved in facility management. In this connection, designers, urban planners, building authority officers, preconstruction managers, construction managers, TSI (technical supervision of the investor), TSB (technical supervision of the builder), bricklayers, machinists, surveyors, geomatics, facility managers, crane operators and construction equipment operators are named.

In terms of quantifying the extent of shifts between different construction professions due to the needs of energy-efficient construction, it can be estimated at around 20,000 people in total. Of these, only about 5,000 will be "brought in" by new graduates of secondary schools and universities in the short term until 2030. This means that about **6% of the current construction workers will change (or expand, upgrade) their qualifications in the given timeframe**. This is undoubtedly a task that will certainly find a place in the new Roadmap.

It is clear that in order that the Czech construction industry adapts to the modernization of the sector and the demands of energy-efficient construction, it will be necessary to increase the capacity in both primary and adult education by 2030, in most cases (craft qualifications) **in a ratio of 1:4 in favour of lifelong learning.**

Based on the available data, an estimate was made of the number of tradespeople and then further estimate of the increase to 2030. Data on employees are well available in the country. However, aggregated estimates had to be prepared according to the sources from the Ministry of Labour and Social Affairs and the Ministry of Industry and Trade. Unfortunately, the availability of data on trades in the Czech Republic is very low, especially for self-employers, and information is often inconsistent. The estimates are also based on trends projected by the National Qualification Platform.

Table 26: Estimated development of the number of on-site workers

	Estimates of self - employers´ share *	Estimates of employee share **				Estimates of growth by 2030	
	Coefficients		Estimates of distribution				
Coefficients of self employers´ /employee share	0,568	0,432	Sole trades	Employee	Total	Total	Growth
Bricklaying (Bricklayers, masons, tilers and dry-builders)	0,331	0,167	75,6	29,0	**104,6**	**108,8**	4 %
Insulator	0,028	0,020	6,3	3,4	**9,7**	**10,7**	10 %
Chimney Sweeping	0,010	0,006	2,3	1,1	**3,4**	**3,4**	2 %
Plumbing, heating	0,127	0,057	29,0	9,9	**38,9**	**39,3**	1 %
HVAC	0,005	0,019	1,2	3,4	**4,6**	**4,8**	5 %
Painters, decorators, painters	0,094	0,005	21,4	0,8	**22,2**	**22,1**	-0,5 %
Roofing, carpentry	0,096	0,022	21,9	3,8	**25,8**	**25,8**	0

Project activities in construction	0,121	0,165	27,6	28,6	**56,2**	**55,1**	-2 %
Construction, alteration and demolition, Management personnel	0,189	0,149	43,2	25,8	**69,0**	**67,6**	-2 %
Construction and operating electricians	0,000	0,043	0,0	7,4	**7,4**	**7,6**	3 %
Construction foremen and related workers	0,000	0,071	0,0	12,4	**12,4**	**12,3**	-0,5 %
Building construction workers	0,000	0,100	0,0	17,3	**17,3**	**16,5**	-5 %
Other	0,000	0,177	0,0	30,7	**30,7**	**30,7**	0
					402,2	**404,7**	**+ 0,6 %**

* Based on data of Ministry of Industry and Trade – Numbers of trades

** Based on data of Average Earnings Information System (ISPV) – Number of employees in Construction industry

Source: IPSV Wage Investigation https://www.ispv.cz/cz/Vysledky-setreni/Archiv.aspx. Prague 2023

MIT Number of trades https://www.mpo.cz/cz/podnikani/zivnostenske-podnikani/statisticke-udaje-o-podnikatelich/pocty-zivnosti-dle-oboru-v-jednotlivych-krajich--222296/

7.2. Evaluation of the survey identification of companies' needs in terms of professional skills

7.2.1. Source of input information

The following findings are based on a survey conducted between 12/2022 and 02/2023.

Out of the Czech respondents contacted, 55 questionnaires were completed and returned. For some questionnaires not all questions were answered. In some cases, the questions were not relevant to the respondent's area of work, in which case the question was not included in the final evaluation statistics, i.e., the base of 100% was lower than the total number of questionnaires.

Respondents contacted

The responses collected come from representatives of various types and sizes of companies, primarily construction companies. The interviewees hold various positions in their companies ranging from top management, HR department, construction managers, construction preparers and sustainability managers. Furthermore, there is a strong representation of design companies.

In order to get as many responses as possible from different areas and from different positions in the company hierarchy, it was possible to interview more than one person per company.

Collecting information

The questions are deliberately conducted in a free form and encourage more informal discussion in order to find out as much information as possible, but at the same time not to discourage respondents by the size of the questionnaire.

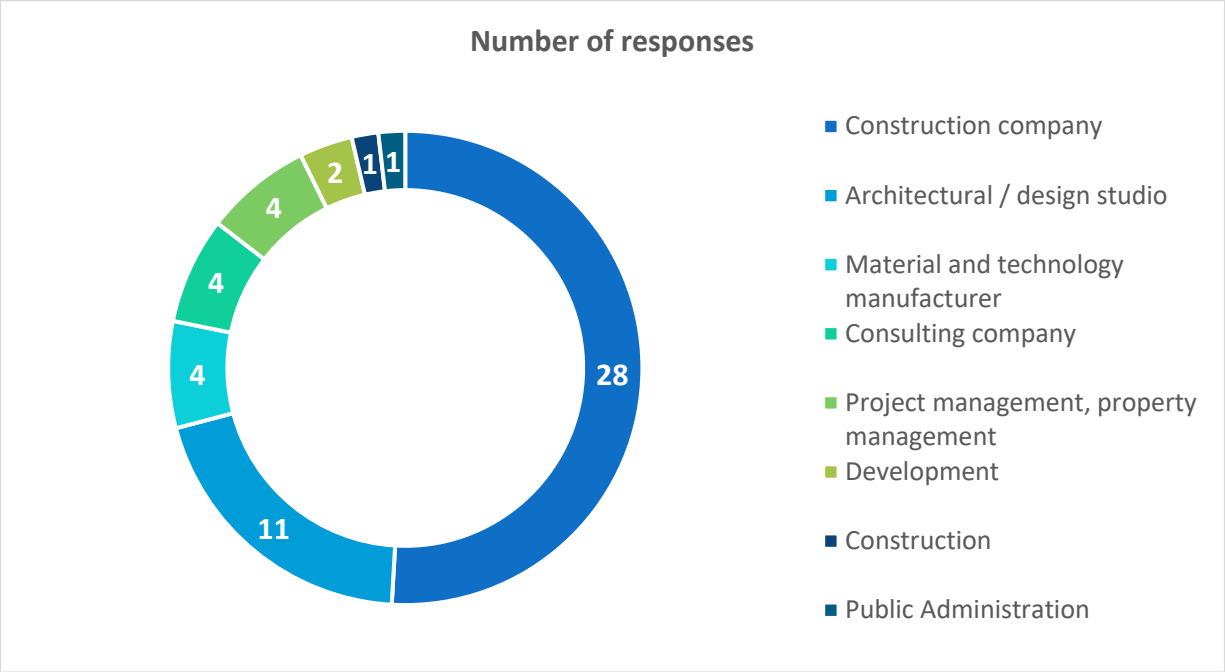
The prepared questions were distributed through all project partners to the individually selected companies/individuals. The envisaged information gathering process had two recommended options:

- sending out questions by email and then contacting the respondents by telephone, interviewing them on the questions and recording them; or
- direct completion of the questionnaire electronically by the respondent.

Out of the 55 responses collected:

- 28 (51 %) were from construction companies;
- 11 (20 %) were from architectural/design studios;
- 4 (7 %) were from project management and property management firms;
- 4 (7 %) were from material and technology producers;
- 4 (7 %) were from developers;
- 2 (4 %) were from consulting firms;
- 1 (2 %) were from building products dealers;
- 1 (2 %) were from public administration.

Figure 12: Distribution of survey respondents



The number of questionnaire responses does not constitute a typical statistical sample when looking at the number of responses compared to the number of businesses on the market. However, in terms of the number of employees employed by the surveyed companies, the survey covers almost 4% of the market (an estimated 15 thousand employees out of a total of 403 thousand in the construction sector in 2020[34]). Even more significant is the share in terms of the turnover of the surveyed companies, which is approximately 17% (about CZK 60 billion out of a total of CZK 580 billion[35] in 2021). The outputs should be interpreted mainly as individual observations from practice – defined barriers and possible solutions or proposals for solutions by individual respondents. The percentage evaluation of individual responses should be seen as very rough and approximate.

[34] Czech construction 2021, MIT, https://www.mpo.cz/assets/cz/stavebnictvi-a-suroviny/informace-z-odvetvi/2022/1/Stavebnictvi-2021.pdf
[35] Czech Statistical Office, 2022, https://www.czso.cz/csu/czso/v-roce-2021-se-u-nas-prostavelo-579-miliard

7.2.2. Questions and answers

1. Do you feel there is a shortage of skilled workers in your company?

Conclusion: the vast majority of respondents report a shortage of skilled workers, with some stating that this is a long-term problem (5+ years) and they see no sign of change in the near future.

2. If so, is it more a lack of theoretical knowledge or practical skills?

Selected comments:

"In the case of blue-collar occupations, we are experiencing a shortage of people who want to do this work. Theoretical knowledge can be learned, practical skills can be acquired through work, but if a worker doesn't want to work, they won't learn anything. For preparatory staff, the lack is clearly in practical skills. Everybody today can work with computer programs at least adequately, but few have the practical experience in construction to do the job well. For construction managers, on the other hand, we feel a lack of theoretical knowledge. Construction managers want to work, they usually go straight into practice on the construction site, but they learn by trial and error. Moreover, they have little motivation to broaden their education, to acquire knowledge or to study correct procedures (Total quality control, standards, ...). Likewise, there is little will to take exams (e.g. railroad M-02, P-02, ...) to get authorizations."

"It is mainly a shortage in the sense of demand x supply. The number of graduates from apprenticeship centres and the total number of craftsmen does not cover the supply of construction companies."

Conclusion: The vast majority of respondents, in line with question no.1 report a lack of theoretical knowledge as well as practical skills among employees. There is a slight prevalence of demand for practical experience. The depth of the problem is captured by frequent mentions of an overall shortage of workers regardless of their qualifications and experience.

3. Which professions do you miss in your company/subcontractors?

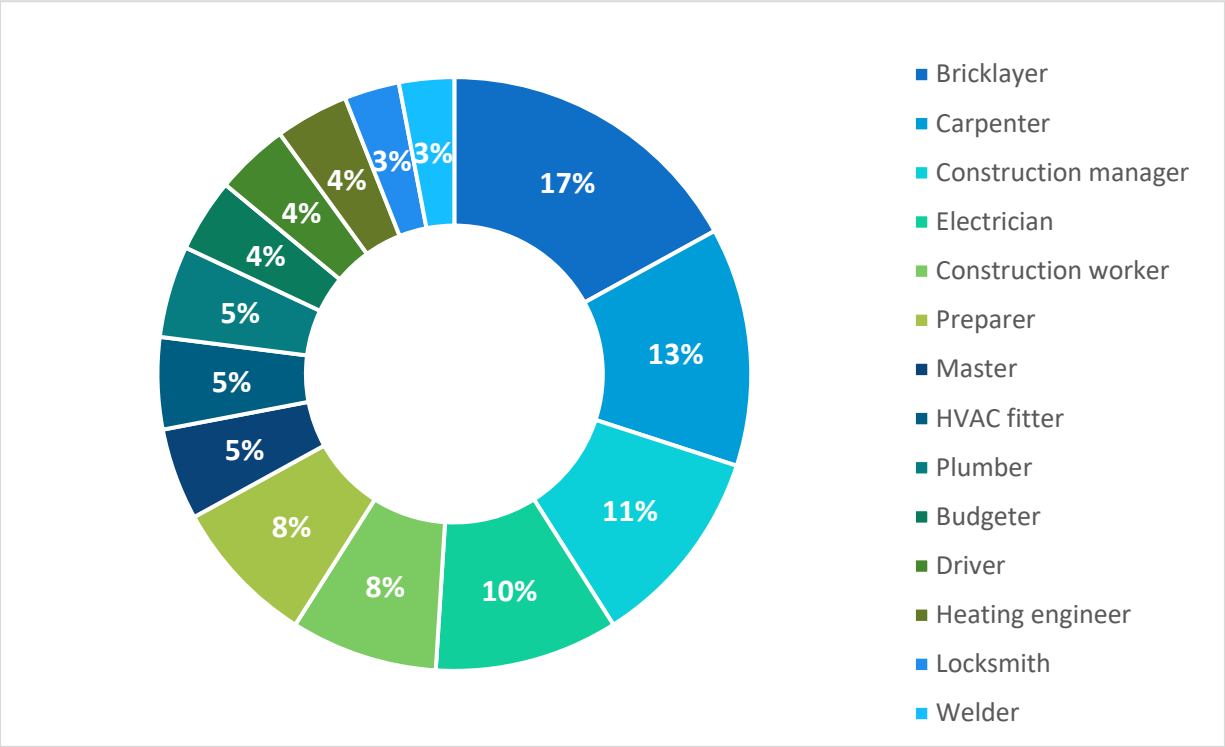
The most frequently mentioned missing positions are bricklayer (16x), carpenter (12x), construction manager (10x), electrician (9x), construction worker (8x) and preparatory worker (8x).

The positions of foreman, building services installer, tinsmith, budget expert, driver, heating engineer, locksmith, welder are mentioned several times (3 to 5 times).

This is followed by the naming of many occupations (at least 1 occurrence) that cover basically the whole range of construction activity, including drywallers, plasterers, facade workers, tile setters, insulation workers, roofers, plumbers.

Specific mention is made of the critical situation in the artistic trades covering the restoration of historical monuments, i.e. stonemasons, stucco workers and metal workers.

Graph 14: Missing professions



4. How do you deal with the situation? I.e. what technologies, products, methods do you use to improve efficiency?

Conclusion: The long-term nature of the problem is indicated by the noticeable scepticism of several respondents. The predominant solution is subcontracting. As a result, this does not solve the lack of qualified people on the market, it only shifts the problem elsewhere (to other companies). This ultimately affects the customer both in terms of quality of work and meeting deadlines, and e.g. response to warranties.

A minimum of the respondents have their own systematic solutions, they react to the situation by introducing more efficient technologies in production, BIM, they train employees internally and instruct them.

5. Where do you see barriers of the lack of skilled workers?

A number of barriers are identified by the respondents, ranging from demotivation, a poorly set up schooling system, to financial barriers.

The barriers listed below are always mentioned several times, the most frequently mentioned barriers are underlined. Predominantly, the outdated set-up of the school system is considered to be the biggest barrier.

There are 3 basic categories of barriers:

Systemic barriers:

- Poor set up of the education system – graduates are not prepared for practice even in theory, let alone in practical skills; outdated way of preparing for practice;
- Artificial support for generating a large number of university-educated people at the expense of crafts – partly a political barrier; a significantly larger number of primary school pupils go on to secondary schools like grammar schools, there is a shortage of apprentices;
- Lack of an overarching government strategy for the education of apprentices and their preparation for employment;
- In practice, the subcontracting system means the creation of poor working conditions by the general contractor for subcontractor workers (technical and sanitary facilities, unfavourable contractual conditions for subcontractors, poor organization among contractors leading to stressful work) ;
- Unpredictability of the education system – loss of the opportunity to focus early on new fields of study where demand is expected to increase, while at the same time using modern technologies that could increase the attractiveness of studies (robotics, digitalization, sustainability, renewables).

Financial barriers:

- General undervaluation of skilled labour in the construction industry (imbalance between adequate wages for skilled people and low contract prices) ;
- Outflow of skilled workers abroad (cross-border workers) in search of better earnings.

Social barriers:

- Low social prestige – a barrier especially for young people; the common perception that the apprentice – worker is an inferior job;
- Low unemployment;
- Difficulty and strenuousness of technical fields does not correspond to the ideas of the current young generation (in the case of project documentation preparation the tediousness of the work is mentioned) ;
- Demanding physical work in adverse climatic conditions, overall society increasingly prefers comfortable work;

- Time-consuming work, changing work location, separation;
- Shift of society's interest from technical fields to the humanities.

6. How is the demand for specific professions changing and how will it change in the future? (What trends do you expect in terms of the shortage of specific skills, influenced by e.g., Green Deal principles)?

Conclusion: The vast majority of construction companies, manufacturers and designers anticipate an increasing demand for both traditional craftsmen and specialists for "new" fields, based on easier work with technologies, robots and IT in general. These trades are expected to be more attractive and prestigious for young graduates than traditional trades.

7. Who could help you with this and how?

The answer is often of this nature:

"After the experience of the past years, we do not expect any help. However, help at the government level would certainly be helpful."

Conclusion: The lower number of responses to this question suggests a slight scepticism and helplessness of the respondents, as these are long-term problems. Yet, in many cases, firms are unclear about how they will address the issue. This can also be partly attributed to the fact that the respondents specialize in activities other than human resources in their companies.

The main actor in solving the problem is the state, namely the government, MEYS (MŠMT) and MIT, which should adjust the education system, especially apprenticeship, secondary vocational and lifelong education and retraining.

8. How are you (your company) prepared to deal with this future shortage of skilled workers?

Conclusion: The answers are very similar to questions 4 and 7. If the company has any solutions, they usually concern internal and external training of employees or direct cooperation with schools.

9. What form of training of your employees are you interested in?

Conclusion: There is a clear demand and interest in all types of employee education in the form of trainings and courses, mostly attendance-based. This concerns traditional crafts as well as new innovative fields, IT and fields related to the transition to digitalization and robotization.

10. Do you use the National Register of Qualifications (NRQ) where new work qualifications can be obtained?

38 responses in total.

Conclusion: The response that the National Register of Qualifications is not used in the respondents' companies is clearly predominant.

11. What impact will the digitalization of the construction sector have on your company?

35 responses in total.

Conclusion: A small number of companies consider themselves ready for digitalization and use digital technologies themselves. In most cases, digitalization is associated with BIM (see question 12). Digitalization is generally seen as beneficial, leading to optimization of operations, but not to a reduction of work for human resources. On the contrary, the demands on staff will be higher given the need for ICT skills.

12. Have you encountered a requirement to use BIM in your company?

Conclusion: Most of the respondents have already encountered the requirement for BIM in their business activities, but only a small number of companies actually work with BIM. The question is what exactly they imagine by BIM – whether only 3D modelling in the preparation of project documentation or some higher form of "real" BIM. There is a predominantly positive view of BIM in terms of optimizing work on both the project documentation and the execution of the work. However, even here there were exceptions with negative experience. The problem was in the greater human resources required to create the BIM model. This can be partly attributed to temporary inexperience with this type of work. No one mentioned the advantage of systematically concentrating a large amount of complex building information to be handed over by the construction team for the routine operational status.

8. Barriers

The main barrier to the development of the Czech construction and building industry is the complete **lack of a long-term strategy for the development of the sector**, which would be based on generally accepted and adopted needs of settlement development and the formulation of technical, legislative and investment instruments to achieve such a goal. Construction is significantly shaped by the needs of the construction market particularly by short-term and campaign-like government measures, often reacting to Europe-wide measures, without meaningful adaptation to our national needs. We have therefore seen the unmanaged development of villages around major cities, causing a large increase in the need for automobiles, the campaigning gasification of many villages, the emergence of solar 'barons', which has caused a subsequent rejection of photovoltaics and, as a result, a lag in the development of solar resources. The state leaves the issue of raw material resources unsupported. **The elaboration of a comprehensive long-term strategy for the development of the construction sector with the state's responsibility for the development of education for the construction sector and for the strategy of settlement development is the biggest barrier and thus a condition for the effective development of the sector.**

The most frequently mentioned **barrier to the development of the construction industry is the lack of workers**. The complaints range from a shortage of manual workers to unprepared replacements for the retiring generation of craftsmen, to a significant decline in students at vocational and technical construction schools and universities over the past decade. High employment, together with the low attractiveness of the sector and especially manual work, resulted in the involvement of a large number of foreign workers. The conflict in Ukraine, a country from which a large proportion of foreign workers have been recruited, highlights the riskiness of this situation. Moreover, the system of recruiting foreign workers faces formal and legislative barriers and is associated with "agency employment" and a black market in workers. The unbalanced sinusoid of the population curve in the past period implied a significant decline in the number of students entering vocational schools and universities. With the growth in absolute numbers in the upcoming generation of high school students, there seems to be an increase in interest in vocational training in general and hopefully in the construction field since last year. **However, there is a complete lack of systemic support for the study of the construction disciplines, support for schools and support for students with scholarships and the like. This is related to the absence of an overall strategy for education in the construction industry. This too can be understood as a significant barrier to the development and modernization of the construction industry in the Czech Republic.**

The construction sector as a field is characterized globally with a low level of added value, and very slow digitalization of the sector as a whole. This is not a specificity of the Czech

Republic, but as the attached graph indicates, the situation is similar across Europe and America.

The construction process, unlike in other sectors, is very long (from the preparation of the investment and project, through its approval, subsequent construction and commissioning, it usually takes 5 or more years). During the process, innovations and new developments are promoted in different phases separately, but the final implementation, according to the "weakest link principle", often presents little progress. The result is always suboptimal and responsive to site conditions. New efforts to perceive the construction, including facility management, that is, the operation of the building and its lifetime, and even including the cost of its disposal and the return of its materials (recyclability), so far hardly affect the quality and value of the implementation part. Buildings are still mainly assessed for the investment costs of the actual implementation. In an effort to make the process cheaper (or to maximize profit), most contractors are constantly focused on **cheap labour, often only wage workers.** The hope, therefore, is to **find effective tools to move the construction sector out of the search for minimum costs for the design and implementation stage, to focus on lifetime efficiency of buildings, and to encourage involvement in technical and technological development and progression at each stage of the preparation, construction and operation of buildings.**

A specific feature of the Czech Republic is the property structure of the construction sector. Large companies are mostly part of foreign construction and contracting concerns, which often have the nature of an "engineering " organization and a large part of their production is sub-contracted to smaller specialist companies. Medium-sized and often specialized firms, act as subcontractors (drywall installers, chimney sweeps, heating engineers, electrical installers, installation organizations, building foundation organizations, etc.) and focus on maximizing the use of specific technology, installing specific products and have specific technical equipment. However, the largest part consists of self-employed individuals (comprising over 40% of the workforce) who are selectively involved in larger projects as temporary contract workers. They individually provide a large proportion of all reconstruction and renovation work for smaller private builders or are 'contractors' on their 'self-help' projects. **The orientation towards progress and the conditions for the use of vocational training and lifelong learning is fundamentally different for each of this group, but this is not usually matched by educational practice or the outputs of educational projects.**

Legislative conditions do not favour progress and complicate the possibilities of promoting progressive trends in the construction sector. The most frequently mentioned obstacle is the length of construction approval, where the deadlines for building proceedings are influenced by numerous (over 40) binding opinions based on often uncoordinated and contradictory legislation. These obstacles and undignified legal practices lead to approval periods for construction projects that can extend up to a decade, during which the original technical

concept becomes outdated and often the functional specification changes its content, further weakening the ambition for technical progress in construction. The bureaucratic formalism in many opinions and objections often does not address the substance of the projects, but applies an alibi of the approving authorities, which often hides ignorance, reluctance to innovate, incompetence or, yes, even complete uselessness of the opinions issued. There is little hope for improvement with the new Building Act under discussion, due to the increasing number of sections and thus further complications in the approval process. The second issue is the form of procurement under the Public Procurement Act, which distorts more than half of the market that has to follow it for public procurement. Here, individual project stages and deliveries are often procured separately, usually either entirely or significantly with an emphasis on the lowest prices. A low-cost project may result in a more expensive construction with many changes and additional works and a low-cost construction may have a more expensive operation or a shorter lifetime, etc. **Attempts to formally remedy most of these regulations only result in a clarification of the legal alibis, but do not increase the pressure for greater competence and accountability of the various participants, nor for higher quality construction.**

The education system has consistently suffered from the distance between practical requirements and the rigidity of traditional educational and academic approaches, which are superior to the need to prepare and train new knowledge and skills for practice. There are a number of issues here, such as how to link school and top practice, the use of the ABF Rating to select companies from practice as partners of schools for top practice, enabling the participation of leading experts, practitioners, in the educational process, without the barriers of "pedagogical" attestations. Other issues are the introduction of the master craftsman´s certificate and its legalization as a condition for the management of a professional firm, the strengthening of professional guilds and communities and the recognition of apprenticeship certificates. The ineffectiveness of the work within the NSO and National Register of Qualifications (NRQ) is alarming, with more than 70% of the companies in the industry not using these materials, considering them irrelevant for the placement of workers, or not even knowing them. The fact that a large proportion of vocational and university graduates do not enter construction practice is also bad news. **The task of transforming education for future digital and robotized construction is the most serious challenge**, but it is also a path to engage the younger generation in creative fields and popularize them. The situation requires gradual but fundamental transformations at different levels: vocational education, secondary vocational education, and university education. Additionally, each of these systems is managed by a different authority (Ministry of Education, Youth and Sports, regions, Ministry of Industry and Trade). **Lifelong learning has neither a proper legislative administration nor a financing system** and is, with the exception of Law 360/1992 (Authorization Act) for CCA and ČKAIT

(Czech Chamber of Engineers and Technicians working in Constructions), training requirements for officials under the responsibility of the Ministry of Interior and some other regulations (energy inspectors, chimney inspections, electrical inspections, etc.), left entirely to the private sector without systemic support.

Material limits present another barrier. The construction sector is generally dependent on a domestic material base, as importing large volumes of material over long distances is a way of increasing overall costs and denying the tendencies of green Europe. At the same time, the production of most domestic materials is relatively energy-intensive (bricks, concrete – or cement, glass, metal structures, ceramics), or does not have sufficiently developed technologies in the Czech Republic (wood processing, plastic for window frames). There is no long-term perspective for domestic gravel and sand extraction. Newly, only pilot-tested sources are recyclables, where the path to standardization and homogeneity of the products and the possibilities of their use are being sought. New modern high-end materials are still finding their way to broader application, which is very complicated in the long-term construction preparation process. **The application of new technical devices and IoT elements is confronted with both the length of the construction process and the different understanding of the lifespan and application of cutting-edge products with often shorter lifespans in the long-term operation of the building.**

Financial resources and economic cycles and their incorporation into the construction sector are areas where the long duration of the construction process is also reflected. The construction sector always responds to recovery with significant time delays. Ensuring the continuity of public investments is, therefore, one of the crucial issues. Another issue is bank lending, which will increasingly apply the European requirements for GreenDeal4Building, i.e., extensive documentation of the green approach. This approach threatens to put medium and small companies at a significant disadvantage, as it will be much more challenging for them to document the necessary requirements, and this will make it more difficult for them to obtain credit financing. **The question is whether additional bureaucratic conditions will lead to an improvement in construction quality or make it faster or cheaper, or if they will only result in further growth of consulting firms that profit from the documentation process of construction financing. As a consequence, this could lead to an overall increase in construction costs and stagnation of construction productivity.**

European requirement of the renovation wave is neither methodologically nor organizationally ready in the Czech Republic. Historic built-up area can be divided into several relatively independent structures: the first group encompasses protected historic cores of villages and towns, often enjoying monument protection. This structure is formed by individual buildings **requiring an individual approach and extensive historical but also traditional craftsmanship skills, here the question of capacity (human and material) comes to the fore.**

The second group is the built-up area from the second half of the 19th to the first half of the 20th century, which often represents a valuable building structure, but requires significant modifications in terms of energy and equipment and individual approach is needed here as well. A separate sub-group is rural development from this period. For buildings belonging to this structure, mostly restituted or privatized, there are **no programmes to motivate their renovation**. The forms of renovation that have been carried out are either oriented towards higher standard housing or towards changing the function to non-residential (offices and other) premises, thus impoverishing the housing stock and the housing function in often central parts of especially larger cities. The third group is housing estates, which represent the largest amount of the existing housing stock to date, their lifetime is approaching its limit and their first phase of renovation (the Panel programme) is practically no longer functioning. **However, we are faced with the decision of whether (and where) to start the second phase of renovation or, on the contrary, whether (and where) to start demolishing the panel housing estates. This question, which is the broadest in terms of volume, is not currently being systematically prepared and studied in a comprehensive way.** The question of renovation of buildings from the last era, which meant the development of mainly family houses and only complementary housing construction, raises issues other than renovation (questions of retrofitting new development communities, questions of their transport accessibility, questions of finding employment opportunities in the place of their construction, or questions of working from home). **The objective of affordable rental housing is completely new.** However, in order to achieve this, it is necessary to prepare a highly rational construction. This will require a return to typification and the advent of robotization. The aim is cost-effectiveness, utility value of new flats and the complexity of residential complexes: a new Bauhaus, new requirements for on-site work, reduced transport demands, and an emphasis on leisure facilities. **There is a lack of a strong politically supported effort to promote the intentions and ideas outlined in the Architecture and Building Structure Policy, the preparation of modern building design systems for affordable rental housing, as well as the zoning of such construction and a philosophy of comprehensive financing.**

It seems that some issues of building and construction have completely or considerably disappeared from the attention of Czech science. The Czech Republic gave a record 2% of GDP to science and research in 2021. Nevertheless, the construction sector and issues related to architecture and community development are a “Cinderella” that certainly does not receive support corresponding to 6-8% of GDP. The places where construction research is developed are universities and their research institutes (such as, the University Centre for Energy Efficient Buildings of CTU or the Central European Institute of Technology). The Academy of Sciences does not have a specialized institute dealing with issues of construction, architecture or urban planning. Nor the MIT and the MRD have any departmental research institutes whose outputs

would help to find and solve construction issues. This is evident in comparison with the situation of 30 years ago, when several institutes were involved in the preparation of the concept of construction of housing estates: Research Institute of Construction and Architecture (VÚVA), Czechoslovak center of construction and architecture (ČSVA), Institute of Forensic Engineering (USI), Typization Institute, Military Social Security Office (VUSZ) and others with a capacity of about 1,000 employees). Private research, which is carried out by manufacturers of building materials but also software services and large contractors, is not separately statistically monitored for the construction sector and is used for a protected competitive advantage in the construction market. **The activities of a number of non-profit organizations and associations, which mediate the knowledge gained through conferences and trainings for their members, or, like SEVEn and ABF Foundation and others, organize ad hoc teams of external staff to work on specific grant tasks and promote the knowledge gained in practice, are evidence of the lack of a research sector.** A similar effort has been made by the Czech Chamber of Commerce to introduce a master craftsman examination that would allow individual professional guilds to systematize both the issue of Lifelong Learning and to give an unambiguous "brand" to efforts to push for qualification and expertise and thus quality of individual professions.

The Czech Republic does not have a single central administrative institution responsible for construction and building issues. The MIT is responsible for energy policy, the construction of energy networks and resources, the production of building materials and the construction industry in general, and the introduction of BIM. The MRD is responsible for the construction law and spatial development, public procurement, housing and support from European funds, the ME has the largest budget available for the support of energy savings, the MT deals separately with investments and legislation for transport construction, the MC has its competences in the field of monument preservation, the MI in the field of education and methodology of local governments, the ME in the field of construction of university campuses, the MEYS in the field of physical education and youth care, and individual regions implement a number of regional or local investment programmes. Even the issue of vocational education and training of professionals for the construction sector is not managed from one central body. The affordable housing and renovation wave is also an unfortunate example. Its framework is defined by the MRD and MLSA, but it does not address construction and technical issues, and investment issues are left to local governments that are not professionally prepared for such construction activity. The technical solution of affordable but quality construction is not addressed at all. This is also reflected in the number of flats being built and even several dozen different financial support programmes are not enough of an incentive. However, investment money is only a fraction of the cost that the MLSA spends as support for housing for socially vulnerable groups. Yet these funds do not bring about a purposeful improvement of the situation, but only bridge the immediate need of the affected citizens and ultimately continue

to accelerate the inflationary spiral despite the profits of housing providers. **Repeated attempts to create one central body responsible for and carrying out effectively state investment policy and construction management, or at least a permanent government commission for construction and building to coordinate fragmented activities and complement missing links, have failed to develop over the long term.**

9. Conclusions

The status quo analysis of the Czech construction industry reveals, above all, that the sector as a whole is not currently in the best shape. Its performance, the number of workers and labour productivity are stagnating, and this situation has been going on for so long that part of the capacities seem to be irretrievably lost. The pressure to build cheaply ('cheap at all costs'), dictated partly by the market (for private investors) but largely by Public Procurement Act (for public investors), pushes to reduce the personnel costs (especially nowadays, when the costs of materials and energy are rising). As a result, average wage in the sector lags behind the other industries, making the construction sector less attractive, especially for skilled labour. This has resulted in a situation where there has been a long-term outflow of skilled personnel from craft occupations (either to other sectors or to retirement), which are not replaced by graduates of secondary vocational schools and apprenticeships. The attractiveness of the sector, especially for young people and women, is also declining. The labour shortage has thus already become a latent condition that severely limits the demands that construction firms can make on the workforce (including its motivation for further training), even within the "traditional" construction sector.

The Czech construction industry is not able to respond to demanding challenges posed by the requirements for energy-efficient construction and the demands for revolutionary process changes in construction (such as digitalization and the application of IA) and is not able to focus on strategies to adapt to these technical and technological requirements.

The construction education system is inflexible and unable to ensure the education of workers corresponding to the technical and technological requirements of modern construction 4.0.

The implementation of Czech commitments in the field of sustainable construction and renovation on national and EU levels cannot be left to the internal forces of the construction sector alone; strong state intervention will be necessary here – especially in terms of removing barriers to progress. Of these, two appear to be crucial:

a) **the absence of a single administrative institution responsible for the development of the construction sector**, and
b) **the absence of a long-term strategy for the development of the construction sector at national level.**

The new Roadmap will undoubtedly have to respond to all these problems.

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11. Glossary

3D model	Digital representation of the physical and/or functional part of the designed building in a structured form (similar to the structure according to ČSN ISO 16739). It contains only geometric data suitable for the visualisation of the structure.
ABF	Architecture and Building Foundation
AI	Artificial Intelligence
AR	Augmented Reality
Automation	Refers to the use of automatic control systems to control technological equipment and processes. In terms of industrialisation, it is the step following mechanisation. While mechanisation provides people with equipment that makes their work easier, automation reduces the need for human presence to perform an activity.
BAU	Business as usual
BIM	Building information management, Buiding information modeling Czech fixed equivalent is "Informační modelování staveb". It is a process of design, construction and management of a building that uses electronic object-oriented information.
BIM model	BIM model-digital representation of the physical and/or functional part of the designed building in a structured form (similar to the structure according to ČSN ISO 16739). It may contain geometric and technical or other non-geometric data required for permissible purposes of use. The model is part of the BIM design documentation.
BMWK	German Federal Ministry for Economic Affairs and Climate Action
BUT	Brno University of Technology
CCA	Czech Chamber of Architects
CEDEFOP	European Centre for the development of vocational training
CPHF	Census of Population, Houses and Flats
CZNACE	Nomenclature statistique des activités économiques dans la Communauté européenne -CPHF Czech Republic
CZSO	Czech Statistical Office
CZU	Czech University of Life Sciences
ČKAIT	Czech Chamber of Authorized Engineers and Technicians active in construction
ČSN	Czech technical standard
CTU	Czech Technical University
EED	Energy Efficiency Directive (EU/2023/1791)
ENEX	Database which contains information from documents prepared by national energy experts (for example on the construction or renovation of buildings)

EPBD	Energy Performance of Buildings Directive (EU/2010/31)
ESIF	European Structural and Investment Funds
FAST VUT	Faculty of Civil Engineering BUT
Fsv CTU	Faculty of Civil Engineering CTU in Prague
EU	European Union
GDP	Gross domestic product
HVAC	Heating, ventilation, and air conditioning
ICT	Information and Communication Technologies
IoT	Internet of Things
KPI	Key Performance Indicator
IEE	Intelligent Energy Europe Programme
LLL	Lifelong Learning
LLLP	Lifelong Learning Project
MC	Ministry of Culture
MI	Ministry of Interior
MIT	Ministry of Infrastructure and Trade
ME	Ministry of Environment
MEYD	Ministry of Education Youth And Sports
MLSA	Ministry of Labour and Social Affairs
MRD	Ministry of Regional Development
MT	Ministry of Transport
NGO	Non-governmental organization
NPI	National Pedagogical Institute
NPO	National Renewal Plan
nZEB	Nearly Zero Energy Buildings
OP	Operational Program
PENB	Building energy performance certificates
RES	Renewable Energy Source
R&D	Research and development
SEP	State Energy Policy
SMART	Specific, Measurable, Assignable, Realistic, and Time-bound
SQA	Status Quo Analysis
TU	Technical University
VR	Virtual Reality
VSB-TUO	Technical University of Ostrava
ZEB	Zero Energy Buildings

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