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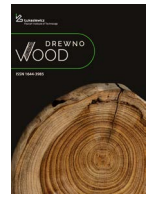
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Timber Construction in Poland: An Analysis of Its Contribution to Sustainable Development and Economic Growth

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In response to global efforts towards sustainable development, an increasing number of Polish companies are focussing on sustainable construction. The quest to reduce the negative impact of economic activities on the natural environment is gaining popularity in the business sector. The aim of this publication is to analyse how timber construction – one of the sectors of sustainable construction –, contributes to the achievement of Sustainable Development Goals, with a special focus on the business sector in Poland. The research methods used include: (i) quantitative methods, presenting data on timber construction in Poland, and (ii) qualitative methods, including desk research and the analysis of three timber buildings with different functions - residential, public, and service - to assess the potential for such construction by Polish companies. The analysis shows that between 2018 and 2022, the number of new wooden buildings will increase by 52.18%. However, the share of wooden structures in the Polish residential construction market will remain small, accounting for 0.62% of all projects in 2022, making it the third most popular type of residential investment. The estimated value of the timber construction market in Poland is growing every year, reaching 3.5 billion PLN in 2022. A key factor in the further development of the sector is access to affordable wood materials, which may be limited in the future. In the context of EU regulations, the construction industry, especially those using wood, is gaining in importance and represents an important, though not yet fully exploited, potential for Polish companies.

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Introduction

Timber construction is one of the methods used to counteract the adverse effects of climate change by promoting environmentally friendly and sustainable practices. As part of global initiatives for sustainable development, more and more companies are turning to sustainable construction as a key element of their development strategy. Investments aimed at minimizing the negative impact of economic activities on

the natural environment are becoming increasingly important in the business sector (Pacheco-Torgal, 2014). Timber construction, using environmentally friendly and renewable materials, is an important segment of sustainable building practices (Sayigh, 2022).

Wood is one of the most ecological raw materials, suitable for construction, widely available in nature, and relatively easy to handle (Mazur, Szlachetka, Jeleniewicz, & Piotrowski, 2024; Ramage et al., 2017). Wood has the properties of a superior building material,

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is environmentally friendly, and has a wide range of both final and repeated uses (Goverse, Hekkert, Groenewegen, Worrell, & Smits, 2001); it is also biodegradable (Werner & Richter, 2007), sustainable (Asif, 2009), and recyclable (Sandier, 2003). The ecological benefits of wooden buildings and their construction processes are recognized worldwide (Stocchero, Seadon, Falshaw, & Edwards, 2017; Tollefson, 2017). Due to its wide applicability, wood has been present in most buildings, either as part of buildings made of bricks or stone, or as a basic part of all-wooden buildings. The selection of individual tree species for construction purposes has always had a regional character, and has been guided by local availability and also by the construction properties of the wood (Klein, Bockhorn, Mayer, & Grabner, 2016). Historical wooden buildings and wooden parts of buildings were made from *Larix decidua* Mill wood in the high altitudes of the Swiss Alps and in the Tatra region of Slovakia (Buentgen et al., 2006; Büntgen et al., 2013). Wood from *Picea abies* L. was used in the foothills of the Austrian Alps (Klein & Grabner, 2015), and wood from *Pinus sylvestris* L. was used in the Netherlands and Norway (Sass-Klaassen, Vernimmen, & Baittinger, 2008; Thun & Svarva, 2018). In the lowlands of Europe, wood from *Quercus robur* L., *Fagus sylvatica* L., *Tilia cordata* Mill., *Acer pseudoplatanus* L., *Populus tremula* L., *Betula pendula* Roth, and other species (Akkemik et al., 2019; Dejmál et al., 2014; McCarroll et al., 2019; Roibu et al., 2021; Vitas, 2020) is used. In the course of the time, wood availability in regions of Europe has changed due to the changing percentage of forest cover, forest species composition, and the development of the timber trade (Roberts et al., 2018). In Polish construction, specific wood species are preferred due to their properties and suitability for various applications. Softwood is primarily used for structural purposes, especially in roofing structures, building joinery (such as windows, doors, and staircases), and for flooring boards and plywood. Hardwood species, on the other hand, are most commonly used in carpentry for flooring and finishing work. In practice, construction-grade timber in Poland is almost exclusively derived from two coniferous species: Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* L.). According to the PN-D-94021:2013-10 standard, in addition to pine and spruce, larch, fir, and Douglas fir are also recognized as sources of construction-grade timber. This variety, though less commonly used, expands the range of locally available wood resources, allowing for flexibility in structural and carpentry applications depending on specific requirements (Wdowiak, 2017).

The European Union (EU) aims to achieve climate neutrality by 2050, becoming the first continent in the world with net-zero greenhouse gas emissions (Brodny

& Tutak, 2020; European Parliament, 2021). In this context, the EU is promoting measures known as the European Green Deal, which offers the prospect of achieving climate neutrality, including the use of environmentally friendly materials of biological origin, such as wood, and the promotion of sustainable construction practices, including the renovation of existing buildings (Sonnleithner, 2021), and the implementation of a circular economy approach (Ginga, Ongpeng, & Daly, 2020). Other initiatives that highlight the important role of timber construction in the future include the New European Bauhaus (European Commission, 2022) and the Fit for 55 strategy, which aims to reduce carbon dioxide equivalent emissions (CO₂e) by 55% by 2030. Although the current share of wood as a construction material in the EU is only 3%, this indicates a huge untapped potential (European Economic and Social Committee, 2023).

In human activities, such as business management, one of the ways to reduce the negative impact on the environment is to manage and optimize a company's carbon footprint. The carbon footprint includes emissions of carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), ozone and other gases. The measure of the carbon footprint is one kilogram of carbon dioxide equivalent (CO₂e) (Mazur & Olenchuk, 2023). A company's carbon footprint, especially in the context of construction, is a key environmental indicator that reflects the total greenhouse gas emissions produced directly and indirectly by the company (Matthews, Hendrickson, & Weber, 2008; Walenta, 2021). In the construction sector, this footprint includes emissions from the production of construction materials and the execution of construction projects. For buildings, the carbon footprint is calculated for the entire life cycle of the building, from design and construction to operation and end-of-life (Goldstein & Rasmussen, 2018). Implementing strategies to reduce CO₂e emissions, such as using materials with a lower carbon footprint, energy-efficient technologies or recycling methods, is becoming essential for companies striving for sustainable development (Lozano, Carpenter, & Huisingsh, 2015). Incorporating timber construction into a business strategy can make a significant contribution to reducing the overall carbon footprint, which is not only good for the environment, but can also be an important element in building the company's image as one that is environmentally responsible and aware of the challenges associated with climate change (Heikkurinen, 2010; Widyastuti, Said, Siswono, & Dian, 2019).

Currently, there are major differences in sustainable design research and sustainable construction. Therefore, it is important to find a more comprehensive strategy that would recognize the value of the interactions between urban design, buildings, construction

systems and materials. Furthermore, it is essential to understand the entire building construction process, from design planning to construction, operation and maintenance. Negative effects of construction of traditional buildings on the environment can be reduced by using suitable environmentally friendly materials and technologies. New buildings should make efficient use of local energy, water and building materials resources. A holistic approach to the construction of new buildings has the potential to reduce the carbon footprint and energy consumption (Vijayan et al., 2023).

Sawn timber and engineered wood products (EWP) are gaining importance in the European construction market, driven by increasing environmental awareness and technological advancements. Demand for these materials is shaped by environmental factors and modern construction practices that favor sustainable solutions. Over the past decade, the EWP market in Europe has seen significant growth, fueled by improved cost competitiveness and a growing interest in renewable materials (Manninen, 2014). Products such as glued laminated timber (glulam) and cross-laminated timber (CLT) are increasingly used in construction, serving as alternatives to traditional construction materials such as concrete and steel (Kibert, 2021; Teischinger, Krug, Sandberg, & Tobisch, 2023). Innovations in EWP technology, including enhancements in strength parameters and surface metrology of sawn timber, optimize production processes, minimize waste, and improve product quality (Kendall H. Bassett et al., 1996; Rebegiani, Reddy, Olofsson, & Fredriksson, 2024). These materials also contribute to CO₂ emission reduction in the construction sector, aligning with sustainability goals (Yadav & Kumar, 2021).

Investing in timber construction can provide businesses with additional economic benefits, particularly in terms of cost efficiency and operational effectiveness. Timber as a building material offers greater speed and flexibility in construction processes, which can shorten project timelines and reduce labor costs, especially through the use of prefabrication (Van Niekerk, Brischke, & Niklewski, 2021). Such simplifications not only accelerate the return on investment but also enable better customization of projects to individual needs. At the same time, timber construction has a positive impact on quality of life and human health. The natural properties of wood, such as its ability to regulate humidity and maintain thermal balance, as well as its beneficial impact on indoor air quality, contribute to creating a comfortable environment for residents or employees (Hoadley, 2000). Such conditions can lead to higher productivity and employee satisfaction, which is an important aspect of human resource management (Ryan, Browning, Clancy, Andrews, & Kallianpurkar, 2014). Despite positive projections, further

development of the EWP market in Europe requires addressing challenges such as the shortage of skilled labor and the need for education in new construction technologies and practices.

In the context of doing business, an increasingly pressing issue is how to save energy, which can be achieved by designing energy efficient buildings (Mazur, Resler, Koda, Walasek, & Daria Vaverková, 2023). The growing importance of this issue is primarily due to the continuing increase in energy costs, which represent a significant portion of a company's operating expenses. The dynamics of energy cost increases are often unpredictable, making long-term financial planning for businesses a significant challenge. Wood is an effective building material in terms of thermal performance and reduction of thermal bridging due to its natural insulating properties (Rowell, 2012). It should also be noted that a significant number of passive energy efficient buildings are constructed using wood. Energy-efficient buildings, with their ability to minimize energy consumption, offer businesses more stable and predictable operating costs (Xue & Zhao, 2021).

Wooden buildings represent a traditional yet modern building approach. From the point of view of the sustainability of our civilization, the properties of wood are ideal for building materials. The aim of this work is (i) to assess the availability of wood as a basic building material in Poland, (ii) to evaluate its current use in the construction industry in Poland, and (iii) to present the benefits of using wood in the case of three specific selected wooden buildings, considering the achievement of selected global Sustainable Development Goals.

Materials and methods

To achieve the set objective, both quantitative research methodology, presenting data on timber construction in Poland, and qualitative research methodology were used. The qualitative research included desk research and analysis of case studies of three timber buildings with residential, public, and commercial functions, to review the potential for such construction by companies in Poland.

The first area of interest was analysis of the potential of wooden buildings and their applicability in Poland. From publicly available data, the levels of afforestation in Poland and other European countries were compared, and wood production in Poland and selected European countries was analyzed. A further stage was the analysis of the construction of wooden buildings in Poland between the years 2018 and 2023. The shares of particular technologies in completed new buildings were also analyzed. An evaluation of wooden buildings was carried out based on three selected completed buildings. These construction projects were evaluated

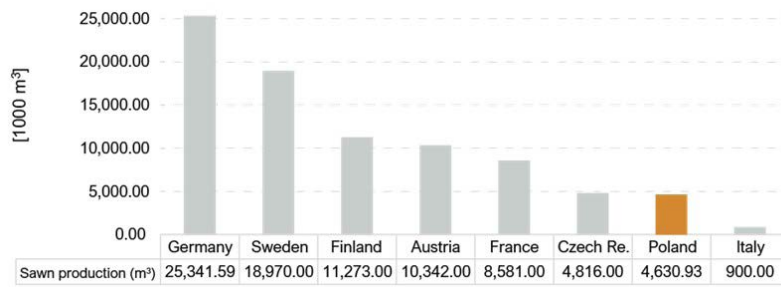


Fig. 1. Sawn timber production for selected EU countries in 2022. Data source: Eurostat (Eurostat, 2023)

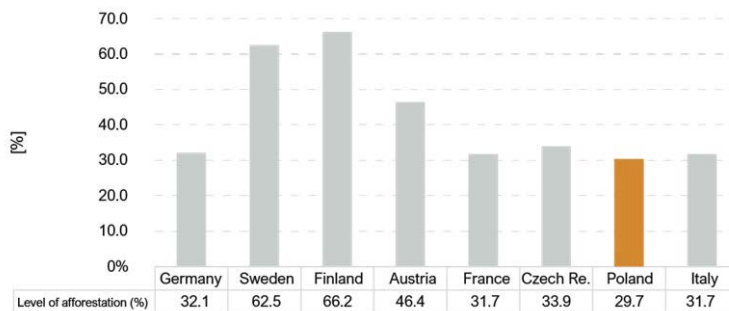


Fig. 2. Level of afforestation for selected EU countries in 2022. Data source: Eurostat (Eurostat, 2023), and GUS (GUS, 2023a)

in case studies, concerning a modular multi-family house in Mysłowice, the Jabłoniowa Educational Center in Gdańsk, and a prefabricated service building in Ostrów Wielkopolski. In the case studies, the benefits of selected construction projects were evaluated from the point of view of meeting the global Sustainable Development Goals.

Results

1. Potential of Polish companies

As a first step to assess the potential of wooden buildings and their applicability in Poland, it is necessary to evaluate the raw material potential of the domestic market. In some EU countries it can be observed that a high level of forest cover leads to a higher level of development of timber construction. Such assumptions are confirmed by Eurostat statistics, which show that in 2022 the most forested countries will be Finland (66.2%) and Sweden (62.5%) (Eurostat, 2023). In these countries, timber construction is widely used for various building projects, such as single-family houses. In Finland, wood is used for 95% of all single-family houses (Sun, 2016), and in Sweden the figure is 90% (Landel, 2015).

Sawmill production is an important economic indicator for the countries of the European Union, reflecting both processing capacity and efficient

management of forest resources. In the context of sustainable development, analyzing sawmill production in relation to the forest cover of each country can provide valuable insights. The year 2022 provides interesting data in this respect, showing the diversity of both forest management approaches and sawmill production. Countries such as Germany, Sweden, Finland, Austria, France, the Czech Republic, and Poland have the highest sawmill production figures in the EU, despite differences in forest cover (**Figure 1**). Poland has a significant level of sawmill production, despite having a relatively low level of forest cover compared with other EU countries (**Figure 2**).

Analysis of the data in the graphs on sawmill production and forest cover for selected EU countries in 2022 reveals interesting correlations. Germany, in spite of relatively low forest cover (32.1%), leads in sawmill production with 25,341,590 m³. Sweden and Finland, with forest cover of 62.5% and 66.2% respectively, also rank high in production, reflecting a strong link between forest resources and the timber industry. Compared to these countries, Poland, with similar forest cover to Italy (29.7% against 31.7% in Italy), has significantly higher sawmill production of 4,630,930 m³, indicating an efficient use of available forest resources. This is evidence of the efficiency of the Polish timber industry, which is able to generate significant production despite having smaller forest resources. These data can be used as

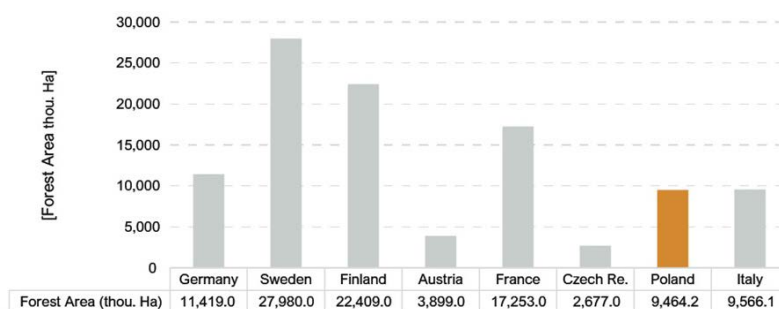


Fig. 3. Forest Area in Selected EU Countries in 2020. Data source: The Food and Agriculture Organization of the United Nations (FAO, 2020) and GUS (GUS, 2022)

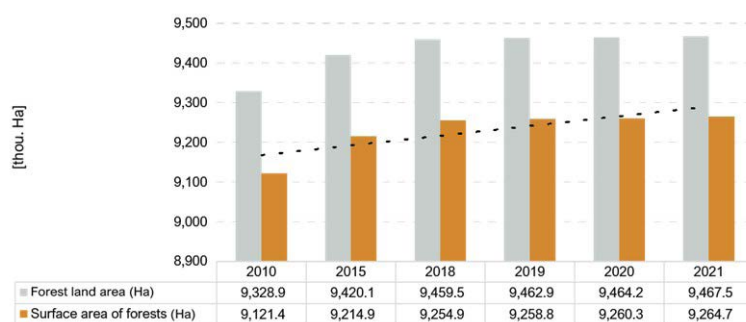


Fig. 4. The land area covered by forests and the surface area of forests in Poland from 2010 to 2021. Data source: GUS (GUS, 2022)

an indicator of the efficiency of the use of forest resources in the context of the sawmill industry and should be compared with data related to forest area.

In 2020, the forest area in selected European Union countries exhibited significant variability, reflecting diverse geographical, climatic, and historical land-use conditions. Scandinavian countries, such as Sweden (27,980,000 ha) and Finland (22,409,000 ha) dominated in terms of forest area, largely due to their location and the favorable climatic conditions that support the growth of boreal coniferous forests. In Central and Western Europe, Germany (11,419,000 ha) and France (17,253,000 ha) had moderate levels of forest cover, influenced by higher population density and a greater degree of urbanization. Meanwhile, Poland (9,464,000 ha) and Italy (9,566,000 ha) exhibited balanced forest distribution, with forested areas serving economic, protective, and recreational functions. The smallest forest areas were reported in Austria (3,899,000 ha) and the Czech Republic (2,677,000 ha), where topography and intensive agriculture limit forest development. This diversity points to potential directions for sustainable development and forest management policies, encouraging countries with lower forest cover to implement afforestation and environmental protection programs, while countries with extensive forest areas may focus on sustainable management practices (Figure 3).

Analyzing the area covered by forests and the area of forests in Poland, it can be seen that in 2010 the area covered by forests was 9,328,900 hectares, while the area of forests was lower at 9,121,400 hectares (Figure 4). In the following years there was a constant increase in both values, so that in 2021 the area covered by forests reached 9,467,500 hectares and the area of forests was 9,264,700 hectares. It can be seen that the area of forests increased faster than the land area covered by forests, indicating increased afforestation efforts or natural forest growth. The increase in forest area from 2010 to 2021 was 143,300 hectares, while the increase in forest area was lower at 138,600 hectares. This reflects the effectiveness of afforestation efforts and an increase in the country's forest density, which is an important element of environmental policy. The decreasing difference between these two values may indicate that an increasing percentage of forest land is being afforested over time.

Based on the analysis of the available data, it can be concluded that companies involved in timber construction can count on a continuous supply of wood resources. This is possible due to the well-developed timber production sector and initiatives aimed at maintaining the growth of forest areas in Poland. It should also be noted that part of the timber is exported, but nevertheless the availability of timber on the domestic market contributes to the development of wood-based

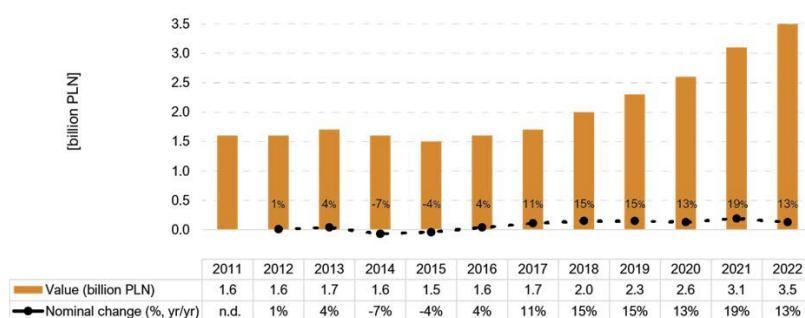


Fig. 5. Estimated value of the wooden construction market in Poland in 2021–2022 (Spectis, 2023, pp. 2023–2028)

companies. In the construction industry in Poland, it is estimated that there are approximately 800 construction companies specializing in wooden structures. Of these, 532 companies focus on frame construction, of which 60–80 offer full prefabrication services. Due to cultural preferences and tradition, companies building log houses are particularly flourishing in Poland; there are around 258 such companies. Most of these companies are small, with only about 30–40 having larger production capabilities (Bidzińska, Leszczyszyn, & Augustyniak, 2020). Despite the potential of the Polish timber construction industry, its full exploitation is hindered by factors such as limited domestic demand. However, the situation varies between companies in the sector. Foreign customers, mainly from Germany, Norway, Sweden, and the Netherlands, play an important role in generating demand for Polish wooden houses. It is estimated that about 4,000 Polish wooden houses are built abroad each year, mostly using prefabricated frame construction (PKO Polish Bank S.A., 2022). Some companies focus exclusively on building projects outside Poland, while imports of wooden houses into Poland remain relatively low. The way in which Polish construction companies are utilizing and developing their potential in the timber construction sector shows that this industry has promising growth opportunities in both the domestic and international markets.

The development of the Polish timber construction industry, although limited by low domestic demand, is progressing through expansion into foreign markets. This trend is opening up new prospects for Polish companies, which are beginning to realize the potential of exporting their services and products. The added value of exporting wooden structures, especially prefabricated ones, can be a significant growth factor for these companies. At the same time, there is growing interest in sustainable building technologies among international consumers, which may stimulate further development and innovation in this industry. Polish companies that build wooden houses and gain recognition in foreign markets can also use this experience

to increase their competitiveness and visibility in the domestic market. According to estimates, the Polish timber construction market will be worth 3.5 billion PLN in 2022, an increase of 45.7% compared with 2011 (**Figure 5**).

Based on the graph in Figure 5, which shows the value of the Polish wooden construction market in 2022, a growing trend in the value of the industry can be observed. Since 2016 there has been a steady increase in the value of the wooden construction market, with the exception of declines in 2014 and 2015. In 2021, the total revenue of the top 50 producers amounted to 5.5 billion PLN, of which 57% came from sales in the wooden construction segment, resulting in a market value of over PLN 3.1 billion. In 2022, the market value will increase by 13% to a record 3.5 billion PLN, highlighting the growing interest in timber construction. Experts also predict a slowdown in the growth of the timber construction market in 2023–2024 due to the general economic slowdown in Poland. At the same time, it is estimated that the market will return to growth in 2025 (Sosna, 2023).

From these observations it can be concluded that the Polish timber construction market is in a phase of dynamic growth with significant potential in the coming years. Interest in timber construction, especially in the context of sustainable development and the environmental benefits of such structures, is likely to continue to stimulate the market. In summary, increased interest in sustainable development in the EU and national regulations may also help to further increase the demand for timber structures. Advances in prefabrication technology and 3D modular construction may make timber construction even more attractive in terms of cost and speed of project implementation. The outlook for the timber construction market in Poland is promising. Despite expected short-term fluctuations, long-term growth trends indicate the increasing role and importance of this industry in economic and environmental contexts, with favorable forecasts for producers, contractors and end users.

2. Timber constructions in Poland

To gain a full understanding of the state of timber construction in Poland, it is crucial to consider the statistical data and trends in this field. By analyzing the data, it is possible to estimate the development potential of timber construction for companies in Poland. Based on data on the number of buildings with timber structures completed in Poland between 2018 and 2022, it can be observed that the percentage of newly constructed residential buildings with timber structures steadily increased (**Figure 5**). This indicates a change in the preferences of both investors and future residents. This trend may have been driven by several factors, including growing environmental awareness, the search for alternative and more sustainable construction methods, and the aesthetic appeal of wood. It is also a result of technological advances that allow wood to be better protected from external factors, increasing its durability and resilience. Although timber structures still represent a minority in the Polish construction market compared with traditional brick and mortar buildings, their share has grown significantly, suggesting a paradigm shift in residential construction and the potential for further development in this area.

Analysis of the data presented in Figure 6 shows that between 2018 and 2023, the number of new buildings with timber structures rose from 658 to 1,303, representing impressive growth of 98%. At the same time, the number of dwellings in these buildings rose from 674 to 1,356, an impressive increase of 101.2%. Particularly rapid growth dynamics were observed in 2020 and 2021, with increases of 22.3% and 21.6%, respectively. However, in 2022 the growth slowed significantly to 7.6%, and further to 4.3% in 2023. This slowdown can be attributed to external factors such as the COVID-19 pandemic and Russian aggression against Ukraine.

However, from the data on the number of completed residential buildings and apartments in 2022 in Poland, categorized by the type of construction used, it is seen that timber construction was the third most frequently chosen method for investment projects (**Table 1**). In terms of numbers of completed dwellings in 2022, timber construction had a small share of 0.6%.

Analysis of the tabular data on residential construction technologies in Poland reveals significant differences in the number of projects completed depending on the technology used. The upgraded traditional technology dominates the market with 110,609 buildings and 207,879 flats, reflecting its deep-rooted position in the construction industry. The monolithic

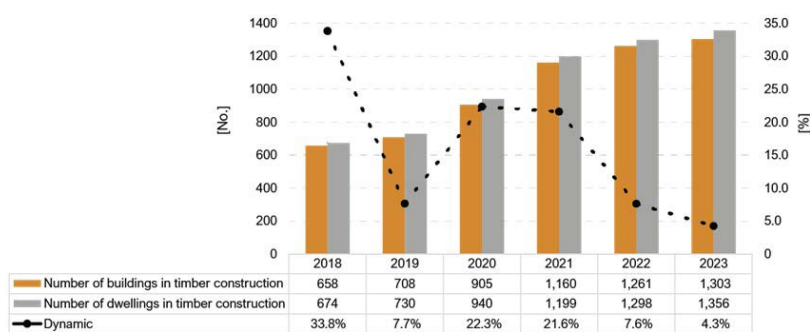


Fig. 6. The number of newly constructed residential buildings with timber structures in Poland between 2018 and 2023. Data source: GUS (GUS, 2022, 2023b)

Table 1. The number of completed residential buildings and apartments in 2022 in Poland, categorized by construction type. Data source: GUS (GUS, 2023b)

Construction technology	Dwellings	Buildings
Traditional technology	207,879	110,609
Monolithic	24,622	354
Timber construction	1,298	1,261
Large panel	1,154	22
Large block	156	7
Other	11	11

method, although less common with 354 buildings and 24,622 dwellings, appears to be the preferred technique for larger construction projects. Timber construction, with 1,261 buildings and 1,298 dwellings, is gaining in popularity, perhaps reflecting the increasing demand for environmentally friendly and energy efficient solutions in construction (Winkler et al., 2022). Large panel, large block technologies and the 'other' category, with a small number of completed buildings and dwellings, are used less frequently, suggesting their niche character or limited application. Overall, the data presented indicate a diversity of technological preferences in the Polish housing industry and a dynamic sector with a tendency to incorporate more sustainable practices.

3. Case studies: Examples of Polish investments in timber construction

3.1. Modular multi-family house in Mysłowice

In Mysłowice, on Karol Miarka Street, an innovative social housing building with 29 rental apartments

was built in 2023. Implemented as part of the 'Energy and Process Efficient Construction' program coordinated by the National Center for Research and Development, the project is a joint effort between the City of Mysłowice, the Municipal Management of Public Utilities and the architecture firm DMDmodular, which collaborated with the Tadeusz Kościuszko University of Technology in Krakow (NCBR, 2023).

Using innovative 3D modular technology, this building was designed with sustainability and environmental considerations in mind (Figure 7a, 7b). It is characterized by its unique ability to generate more energy from renewable sources than is required by the occupants, making it an energy-positive building. This pioneering aspect underlines its role as a model for future green housing investments. In addition, the building was constructed using predominantly secondary materials, a significant step towards reducing the carbon footprint associated with the production of building materials. The commitment to minimizing carbon emissions throughout the construction process is in line with global



Fig. 7. [a] Design of the multi-family modular building in Mysłowice by DMDmodular; [b] Stage of modular building construction. Source: <https://www.gov.pl/web/ncbr/ncbr-pokazalo-ekologiczny-budynek-w-myslowicach> [access date: 13.11.2023]



Fig. 8. [a] Entrance area of the Jabłoniowa Educational Center in Gdańsk; [b] Overview of the entire site development project. Source: <https://www.drmg.gdansk.pl/index.php/s-zrealizowane/307-budowa-objektu-szkolnego-przy-ul-lawendowe-wzgorze-w-gdansk> [access date: 13.11.2023]

trends in sustainable construction and demonstrates the project's commitment to environmental protection. As a result, the residential building on Karol Miarka Street in Mysłówice serves as an example of an innovative approach to urban construction that harmoniously combines advanced construction technologies with the principles of sustainable development, providing residents with an environmentally efficient and comfortable living space.

3.2. Jabłoniowa Educational Center in Gdańsk

In 2019, a modern educational complex called the Jabłoniowa Educational Center was opened in Gdańsk on Lawendowe Wzgórze Street. It consists of two school buildings and a sports hall. The project was designed by TBiARCHITEKCI and implemented by the City of Gdańsk in cooperation with the contractors – EBUD-Przemysłówka Sp. z o.o. and TB INVEST Sp. z o.o. Sp. k. The modern technology of prefabricated timber construction provided by Ecologiq from Gdańsk was used in its implementation.

The complex includes an educational building for 25 school units and a primary school building for higher classes with 22 units. The total educational area of the facility, realized using prefabricated technology, is almost 13,000 m² (Figure 8a, 8b). It includes not only classrooms, but also libraries, a cafeteria, changing rooms, teachers' rooms, school nurse offices and a common room. In addition, the physical education section, including the gymnasium, was built using traditional construction techniques. The Jabłoniowa Educational Center is an example of an innovative approach to school construction, combining ecological solutions with functionality and modern design, and makes a significant contribution to the development of Gdańsk's educational infrastructure.



3.3. Prefabricated service building in Ostrów Wielkopolski

In Ostrów Wielkopolski, on Strzelecka Street, a modern medical center operated by DEA-MED was opened. The service building with an area of 511 m² was built by the Burkietowicz Group (Fig. 9a, 9b). The structure of this facility is based on a timber frame, including specially designed and manufactured glued timber trusses and roof beams. The entire structure was built using prefabricated timber wall (light frame) technology, which was delivered and assembled on site.

This project was developed with a focus on energy efficiency and minimal environmental impact. Its main advantages include cost transparency and a low heat transfer coefficient, making it a highly economical solution. In addition, the wood used in the construction is 100% recyclable. After processing, it can be reused, for example, in the manufacture of wood-based panels, further enhancing the environmental credentials of the investment. Such an approach to construction not only has a positive impact on the environment, but also represents an economically advantageous solution that combines the benefits of modern design with the principles of sustainable development.

The analysis of three completed timber buildings – residential, public and service buildings – confirms the technical feasibility of their implementation in Poland. The examples discussed also demonstrate the competence of domestic companies specializing in timber construction. Furthermore, these buildings were constructed using prefabrication technology: (i) 2D wall panels and (ii) 3D volumetric modules. The development of this technology is considered crucial for the expansion of timber construction in Poland and the European Union. The cases studied show that there are no significant technical barriers that would prevent the realization of such projects by domestic construction companies and timber construction suppliers.



Fig. 9. [a] View of the DEA-MED building in Ostrów Wielkopolski; [b] One of the final stages of construction.

Source: <https://burkietowicz.pl/budynek-uslugowy-w-technologie-szkieletowej/#>

[access date: 13.11.2023]

In addition, there is potential for further growth for companies specializing in the prefabrication of wooden structures in manufacturing plants, including through export production.

Discussion

Analysis of the potential of timber construction in the context of sustainable development reveals significant prospects for the Polish economy. Wood as a renewable material offers an ecological alternative to traditional resources, contributes to the reduction of CO₂e emissions, and optimizes the life cycle of building products. Companies looking for ways to reduce their carbon footprint can find an effective solution in timber technology that meets environmental, social and economic needs. Investing in new timber structures, whether for residential, commercial or public use, as well as upgrading existing infrastructure, can bring benefits such as lower operating costs and improved energy performance (Starzyk et al., 2023).

For example, the construction of buildings using prefabricated elements reduces the impact on the environment. Carbon emissions were reduced by 8.1% as a result of prefabricated construction (Jayawardana, Sandanayake, Jayasinghe, Kulatunga, & Zhang, 2023). The building materials manufacturing sector is also recognizing wood as a resource of the future, enabling the creation of innovative products with improved insulation and structural properties (Pędzik, Júda, Kminiak, Czerniejewska-Wolska, & Rogoziński, 2024). Despite the noticeable impact of the COVID-19 pandemic, which temporarily reduced demand for single-family homes and complicated logistics in the construction sector, a recovery and increased interest in wood technologies is expected. Market analyses predict an improvement as early as 2025, driven by growing environmental awareness, consumer preferences, and political and financial support at both national and EU level.

The construction industry is one of the most important drivers of social development, but it is also one of the greatest threats to sustainable civilization. In the face of environmental challenges, timber construction is emerging as a key response that allows social and environmental needs to be reconciled. By promoting healthy living conditions that do not negatively impact air quality, it addresses Sustainable Development Goal 3. Through energy-efficient projects that reduce energy demand, it addresses Goal 7. Innovative and sustainable building materials resulting from new research and technological development meet Goal 9, and by promoting the recycling and reuse of wood it supports Goal 13. These actions demonstrate that timber construction can be an important catalyst in

the pursuit of sustainable development. For example, by using wood in construction, we can reduce the carbon footprint of buildings, utilize local resources, minimize waste, and support a circular economy. In this way, the construction sector, as one of the key segments of the economy, has a positive impact on a wide range of aspects of human life, from meeting basic housing needs to promoting the sustainable use of resources and environmental protection.

Businesses can effectively use timber construction to achieve sustainable development goals through several key strategies. Firstly, it is important to choose wood from certified sustainable sources that ensure the protection of forests and their biodiversity. Secondly, they should focus on investing in modern technologies that enable the construction of energy-efficient and durable structures. This can help reduce the carbon footprint of their operations and lower operating costs. Secondly, promoting the recycling and reuse of wood contributes to waste reduction and supports a circular economy (Rybak-Niedziółka et al., 2023). Incorporating green spaces and biophilic design into construction projects can further enhance health and aesthetic benefits, while promoting the well-being of employees and customers. By implementing these practices, companies not only contribute to achieving sustainable development goals, but also strengthen their market position and build a positive reputation among consumers and business partners.

One obstacle may be the public's concerns about wooden buildings. Based on a survey by Petruch and Walcher (Petruch & Walcher, 2021) conducted in Austria, young millennials still have preconceived notions that are not in line with the nature of modern timber construction, especially when it comes to technical aspects and sustainability issues. It is therefore necessary to take steps to support a realistic perception of wooden buildings; for example, technical parameters such as fire safety, durability, stability and also the role of wooden buildings in the circular bioeconomy should be presented and clarified to young consumers. Studies of the German market and other selected European countries have shown that wooden buildings are highly rated in terms of so-called "soft factors" such as comfort, aesthetics and eco-friendliness. However, people doubt their stability, modernity, durability, value stability, price, competitiveness and fire resistance (Gold & Rubik, 2009).

In order to effectively increase interest in timber construction, it is crucial that companies and state institutions, such as the Polish Ministry of Climate and Environment, take strategic action. Surveys carried out by the ministry show that Poles have stereotypical perceptions of wooden houses as mountain (73.9%), holiday (67.4%) and rural (56.9%) properties (Ministry

of the Environment, 2017). In order to overcome these deep-rooted associations, it is necessary to emphasize the modern character and durability of wooden structures and the advanced technology used in them. In the Polish architectural tradition, the roots of timber construction go back centuries, as the example of the Church of St Michael the Archangel in Domachowo, with its oak walls from 1369, shows. This is undeniable proof that wood as a building material can last for generations and is at the same time an ecological and aesthetic choice. Another example of the durability of wooden structures is the Baroque Church of Peace in Świdnica, built in 1657 and inscribed on the UNESCO World Heritage List in 2001. Modern technologies and methods of wood processing make it possible to build highly fire-resistant structures. The fire resistance of the structure, rather than the flammability of the material, is now the decisive factor in the fire safety of wooden buildings (Aseeva, Serkov, & Sivenkov, 2014). This is an important message for Polish families who, when investing in the future, are looking for solutions that are not only aesthetically pleasing but, above all, safe and durable. Raising public awareness of the benefits of timber construction can be achieved through information campaigns, educational workshops, showcasing of innovative projects, and working with opinion leaders. This requires integrated marketing and education efforts that highlight not only the historical value of wood, but also its modern applications and adaptability to changing climate conditions.

Conclusion

Based on the available data, it can be concluded that Poland possesses a significant raw material potential favorable to the development of wooden construction. Despite relatively limited forest resources, the country successfully generates substantial production in the timber industry, demonstrating its efficiency in utilizing wood as a building material. With a forest cover of 29.7% of the country's area, Poland ranks 7th in the EU in terms of sawn timber production. In 2020, Poland's forest area amounted to 9,483,000 hectares. Notably, the forested area in Poland increased by 1.5% between 2010 and 2021, underscoring the continuous growth of forest resources and providing a strong foundation for further development in the wooden construction sector.

Wooden construction holds unique potential to support the circular economy. In the context of global challenges such as climate change and the pursuit of sustainable development, wood-based construction technologies are becoming increasingly important. Thanks to wood's ecological properties, such as carbon footprint reduction, energy efficiency, and renewability, wooden construction can form the basis of a more

sustainable building industry, offering both practical and aesthetic solutions. The dynamic growth in the value of Poland's wooden construction market is the best evidence of this trend – in 2022, the market was valued at 3.5 billion PLN, representing a 118.7% increase compared with 2011. Similar trends can be observed in the number of completed wooden buildings, which rose by 98% between 2018 and 2023. This reflects the growing interest in this sector among both investors and the public. The Polish wooden construction market has an exceptional opportunity to capitalize on current trends, such as the increasing demand for energy-efficient and eco-friendly buildings and the growing popularity of sustainable construction practices. Strengthening collaboration between the private and public sectors, increasing investments in research and development, and promoting the benefits of wooden construction could significantly enhance its role in the Polish economy. By pursuing ambitious sustainable development goals, Poland has the potential to become a leader in innovative solutions for wooden construction. Examples of this include projects such as the modular multi-family building in Mysłowice, the Jabłoniowa Educational Center in Gdańsk, and the prefabricated service building in Ostrów Wielkopolski, which demonstrate that fully wood-based construction projects are not only feasible but also economically viable and attractive for investors.

In light of current and future environmental and socio-economic challenges, focusing on wooden construction as a key development pathway could bring multifaceted benefits to Poland. Wooden construction will not only positively impact the environment but will also contribute to long-term economic and social growth, laying the foundations for a future built on sustainable, renewable resources.

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