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## **EVALUATION OF SLOVENIAN CONTEMPORARY TIMBER CONSTRUCTION**

*Considering the growing importance of energy-efficient building methods timber construction will play an increasingly important role in the future. Today wooden buildings in Slovenia represent just a small percentage of all domestic buildings constructed. Currently the growing trend towards wooden pre-fabricated houses is positive. This study is focused on the reasons pertaining to wooden building and the possibilities of increasing the use of timber in Slovenia. Issues like public attitude towards wooden buildings and its advantages were examined by means of Slovenian public opinion survey. The survey revealed the lack of knowledge about wooden buildings and the lack of environmental awareness. The positive trend towards wooden construction is dictated by international guidelines, where wooden building is an important starting point not only for low-energy, but also low-emission building with exceptional health and safety features. Renewable building materials should already be integrated into the early phases of building planning. It is expected that in the next years there will be a shortage of detached houses in Slovenia, hence an increase in the marked share of wood construction is predicted and there is an increasing need for renovation which is one of the most extensive tasks we will face in the coming years. So as to further enhance the interest in wooden buildings a specialized portal devoted to wood building in Slovenia has been established*

**Keywords:** wood, sustainable development, timber construction, public opinion, residential building, web page, portal, Slovenia.

### **Introduction**

Pollution of our natural environment increases every day. This problem has caught our attention at its very late stage. For a long time the prevailing opinion was that environmental protection measures were too costly. Due to the pressure

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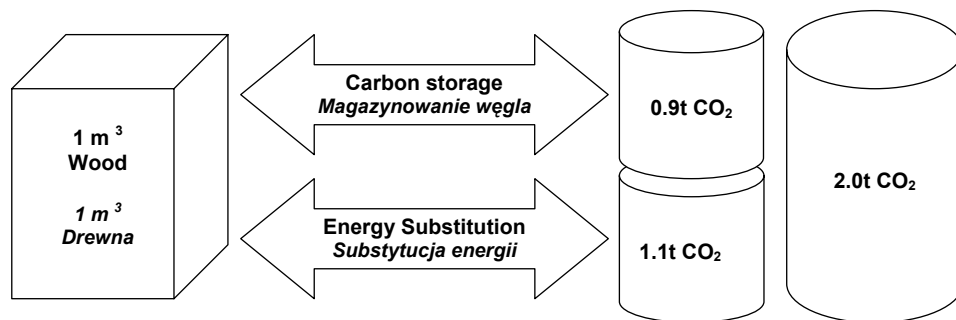
of the environment-conscious public in recent years, an environment-friendly way of thinking has started to penetrate into areas where initially its opponents seemed to be the strongest, i.e. into the economy and industry [Oblak 2007].

Every cubic meter of wood used as a substitute for other building materials reduces CO<sub>2</sub>, because 0.9 tonnes of CO<sub>2</sub> is stored in 1m<sup>3</sup> of wood (fig. 1). Based on these figures a 10% increase in the percentage of wooden houses in Europe would produce sufficient CO<sub>2</sub> savings to account for about 25% of the reductions prescribed by the Kyoto protocol (table 1).

**Table 1. Carbon storage in domestic products**

*Tabela 1. Magazynowanie węgla w produktach dla domu*

| Elements<br><i>Elementy</i>                 | Carbon content (kg)<br><i>Zawartość węgla (kg)</i> |
|---|--|
| House<br><i>Dom</i>                         | 10.000 – 25.000                                    |
| Wooden window<br><i>Drewniane okno</i>      | 25   |
| Wooden flooring<br><i>Drewniana podłoga</i> | 5  |
| Furniture<br><i>Meble</i>                   | 1000   |



**Fig. 1. Carbon storage and energy substitution by wood**

*Rys. 1. Magazynowanie węgla oraz substytucja energii przez drewno*

Due to even greater environmental-protection awareness the ecological potential is also assessed for construction materials: defining the quantity of free CO<sub>2</sub> and invested energy, which is freed up during the production of construction material units. This is why it will be necessary to devote more attention to balanced production and the use of raw materials and energy sources to achieve

sustainable development [Lipušek 2008]. The comparative advantage of wood can be easily represented by the quantity of “grey” energy, i.e. the energy necessary for acquiring and preparing material, assessed using the life cycle analysis (LCA). It may be true that competitive materials or products have certain technical advantages over wood; however, their energy and ecological balance, which are defined by the amount of grey energy and the life cycle analysis, are dramatically poorer than in the case of wood [Torelli 2008] (table 2, fig. 2).

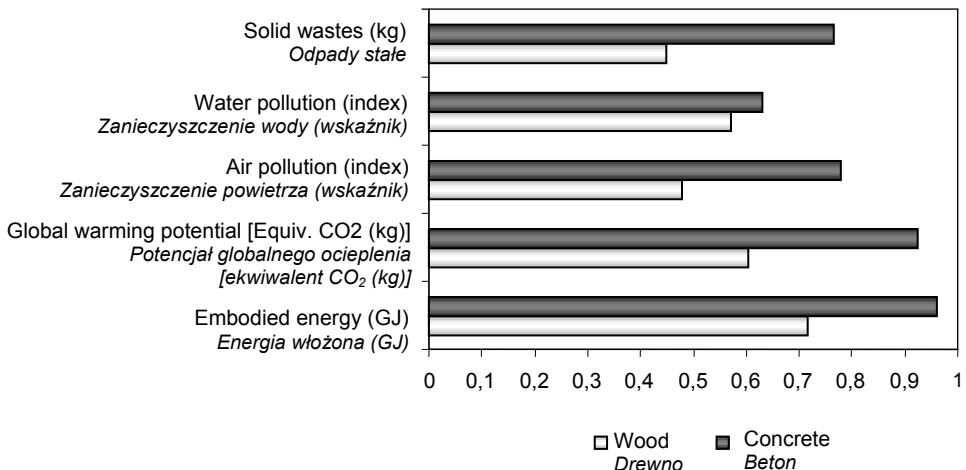
**Table 2. The amount of CO<sub>2</sub> emission and energy used to produce building material: 1m<sup>2</sup> wall element**

*Tabela 2. Wielkość emisji CO<sub>2</sub> oraz energia zużywana do produkcji materiałów budowlanych: element ściany o powierzchni 1 m<sup>2</sup>*

| 1m <sup>2</sup> wall element<br><i>Element ściany o powierzchni 1 m<sup>2</sup></i> | Wood building<br><i>Budynek drewniany</i> | Brick building<br><i>Budynek ceglany</i> |
|---|---|--|
| Weight (kg)<br><i>Waga (kg)</i>   | 71  | 273                                      |
| Energy (MJ)<br><i>Energia (MJ)</i>  | 271                                       | 876                                      |
| Emission (kg)<br><i>Emisja (kg)</i>   | -50                                       | 58                                       |

Source: [Waltjen et al. 1999]

*Źródło: [Waltjen i in. 1999]*



**Fig. 2. Environmental impact of the wooden house vs. concrete house**

*Rys. 2. Oddziaływanie na środowisko budynku drewnianego w porównaniu z budynkiem betonowym*

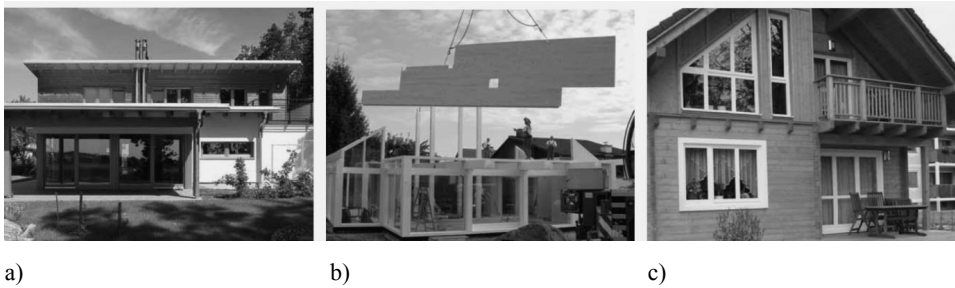
Source: [CEI-Bois 2006]

*Źródło: [CEI-Bois 2006]*

Wood as a material for load bearing construction is a future challenge. For load bearing constructions solid wood, wood-based panels such as plywood, OSB, and particleboard, as well as Laminated Veneer Lumber (LVL), Parallel Strand Lumber (PSL), and Laminated Strand Lumber (LSL) are used. Despite the wide range of wood and wood-based products used for load bearing construction, we have to search for improvement of the above-mentioned products also in their combination with one another (for example I-beam) or with other materials (like load bearing and weight lowering material) [Natterer 2008; Kilar, Vratuša 2007]. Medved [2008] also discussed the advantages of wood and wood-based products as a material for construction purposes and material for tackling the climate change. Timber building is a part of the future energy-efficient building. Wood is sustainable, CO<sub>2</sub> neutral, and highly effective insulator creating excellent living conditions. One specific advantage of wood is its ability to reduce energy consumption. Timber construction is characterised by higher heat insulation value than conventional construction methods, even if the wall thickness is less. An external wall constructed using timber may have only half the thickness of a brick or concrete wall, yet it provides double thermal insulation value at the same time avoiding thermal bridging common among other construction methods. Considering the growing importance of energy-efficient building methods timber construction will play an increasingly important role in the future [Mayer 2010].

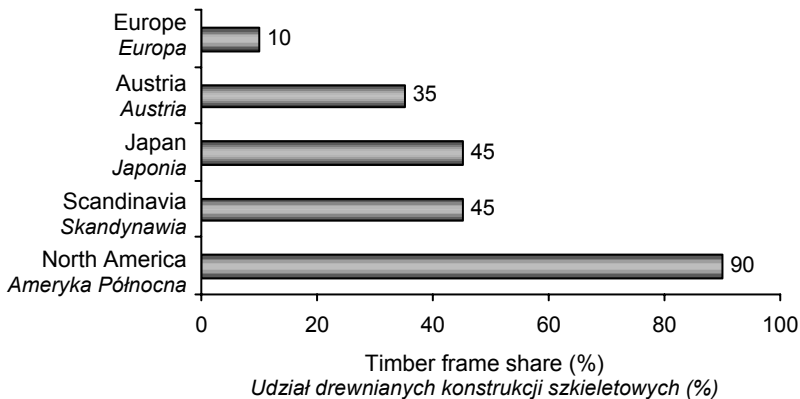
The construction of buildings in Slovenia represents more than half of the construction industry, whereby three-fourths of the activities are intended for the construction of new buildings and only a small share for renovation. The biggest share (47%) of the existing buildings is represented by residential buildings; more than half of the residential buildings are made of brick (56%), 16% are concrete and mixed construction and the rest of the materials, including wood, is represented to a smaller extent. Wood construction in Slovenia is on the rise; however, the percentage of new wood buildings in Slovenia is still small with regard to other newly built residential buildings. In 2008 [SORS] the percentage of pre-fabricated houses built exceeded 10% of all detached and semi-detached houses built and the percentage is expected to increase to 15% over the next five years. In addition to the production of bigger companies, which are united in the association of Slovenian producers of pre-fabricated houses, some number of wooden houses constructed by their owners and carpentry workshops has appeared lately. The board of carpenters at the Chamber of Crafts gathers more than 500 carpenters. In line with the trends in other Alpine regions the percentage of constructions built by carpentry workshops will increase even more.

The dominant methods of wood construction in Slovenia include frame construction, skeleton and massive construction. Most companies in the market offer houses with wood frame construction (fig. 3).



**Fig. 3. a) Panel construction, b) Wood frame construction, c) Solid wood construction**  
**Rys. 3. a) Konstrukcja panelowa, b) Konstrukcja szkieletowa, c) Konstrukcja z litego drewna**

For comparison, in Austria wood construction represents 35.7% of all domestic buildings built per year [pro: HOLZ 2007]. The proportion of wood construction in North America is 90% and in Japan and Scandinavia 45% (fig. 4).



**Fig. 4. Timber frame share**  
**Rys. 4. Udział drewnianych konstrukcji szkieletowych**

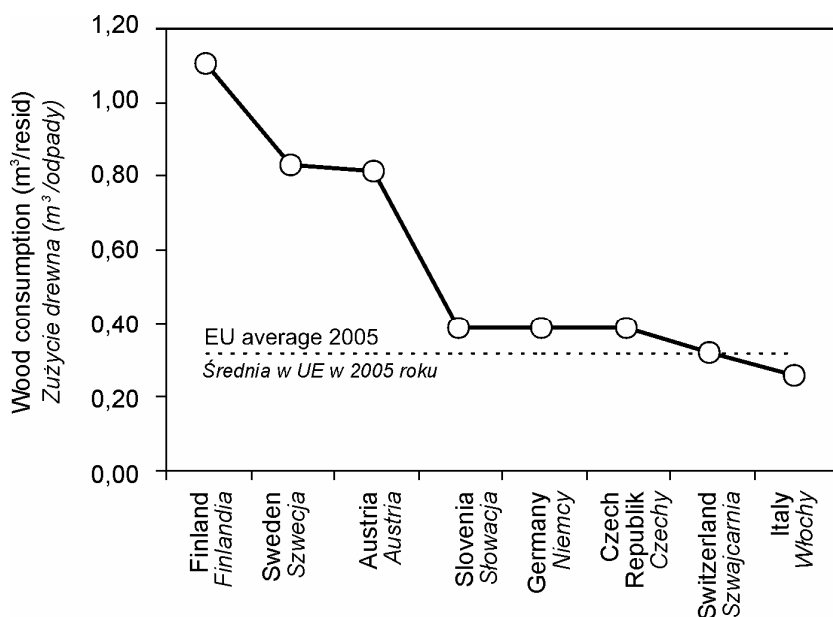
Source: [CEI-Bois 2006]  
*Źródło: [CEI-Bois 2006]*

## Wood product consumption per capita

The per capita consumption of primary wood products is defined by production, imports and exports of selected primary wood products according to FAO definitions, and population. The indicator covers the consumption of sawnwood and wood-based panels (veneer, plywood, particleboards, and fibreboards). The calculated values of wood product consumption per capita indicate the extent of

wood use in construction and the extent of further processing of primary wood products into final wood products, e.g. furniture.

The European consumption per capita of primary wood products is lower compared to North American. Finland, Sweden, and Austria are characterised by the greatest extent of wood and wood-based panel use in construction and secondary processing (packaging, furniture, etc.) in Europe. According to official input raw data Slovenian wood consumption is relatively low compared to available wood resources, nevertheless higher than the European average. An analysis done by SFI indicates that the real consumption may be in the range of 0.60 to 0.70 m<sup>3</sup>/capita (fig. 5).



**Fig. 5. Wood product consumption per capita in selected EU countries, 2005**

*Rys. 5. Zużycie produktów drzewnych na głowę w wybranych krajach UE, 2005*

Source: [UNECE – analysed by M. Piskur, Slovenian Forestry Institute, 2010]

*Źródło: [UNECE – analiza: M. Piskur, Słoweński Instytut Leśny, 2010]*

The study is focused on the reasons pertaining to wooden building and the possibilities of increasing the use of timber in Slovenia. In the Slovenian public opinion survey on wooden building we were interested in people's opinion on the existing wooden buildings, their knowledge about passive houses and their environmental awareness.

## Material and methods

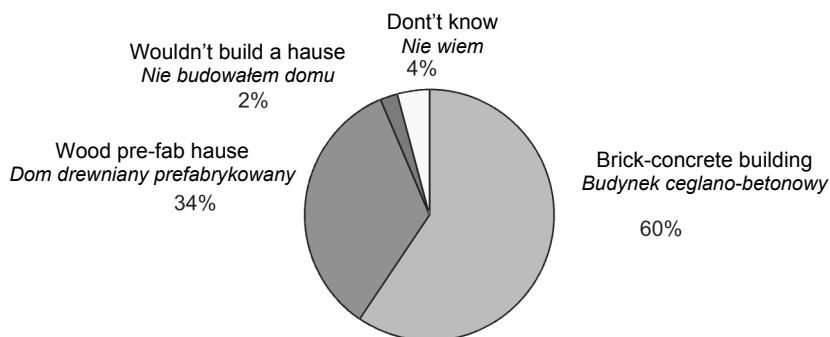
The survey entitled “Slovenian public opinion on wooden buildings” was targeted at respondents between 25 and 40 years of age who were considered potential buyers of wooden houses based on the registry of population. They were chosen randomly, which ensured that the sample represented the whole Slovenian population adequately. Data was gathered using the CATI method (computerized telephone survey). The survey started throughout Slovenia on May 16<sup>th</sup> and lasted until June 3<sup>rd</sup> 2006 and it encompassed 628 respondents. The chosen sample represented all 12 statistical regions of Slovenia and reflected a representative sample of the Slovenian population. A relation between the level of the use of wood for building and demographic structure aspects of the survey sample was especially compiled.

The survey was developed by a research group from the Department of Wood Science and Technology at the Biotechnical Faculty [Kitek Kuzman 2007]. A number of experts in the fields of architecture, construction, and timber construction also provided their input. Each individual featured in the survey was asked 5 questions. In the first question they had to decide between classical brick construction and wooden prefabricated construction. In the following steps they had to list reasons for choosing wooden prefabricated construction. The second question concerned their knowledge about the properties and advantages of wooden prefabricated construction. The third question was similar to the first one, only this time they were asked about a timber-framed penthouse. The fourth and fifth question regarded ecology and the respondents were asked about the ecological aspect of wooden construction and passive houses.

## Results

### Wooden house building

Currently the growing trend towards wooden pre-fabricated houses is positive. By asking the respondents if they would have opted for a traditional construction or a wooden house if they had built a new house, we wanted to determine their hypothetical preferences, if building was to be carried out at that time. Results indicate that 60% of the respondents would have decided for a traditional brick-concrete building, whilst 34% would have decided for a timber construction. The main reasons for not deciding on a wooden house are barriers connected with perception, tradition, habit, and the lack of knowledge (fig. 6).

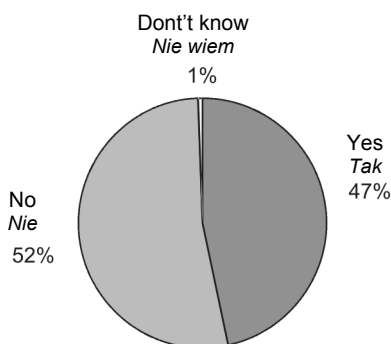


**Fig. 6. If you built a house, would you prefer a traditional brick-concrete house or a wooden prefabricated house?**

*Rys. 6. Gdybyś budował dom, to wolałbyś tradycyjny dom ceglano-betonowy czy drewniany prefabrykowany?*

### The advantages of wooden buildings

Less than half of the respondents are familiar with the advantages of wooden buildings: environmental friendly material, energy conservation, short construction time, fire resistance, more living space etc. The results of the survey showed that less than half of the respondents (47%) knew the advantages of wooden construction, therefore we could claim that general knowledge about wooden construction was poor (fig. 7). The respondents who were familiar with the advantages of wooden construction were also asked to say what those advantages were in their opinion. The biggest advantages according to the survey results were: short construction time, ecology, better insulation, price, and energy efficiency.



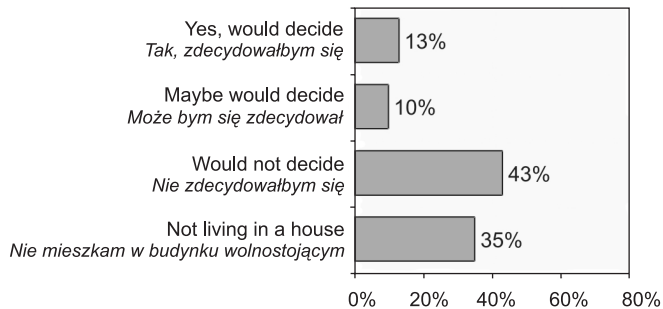
**Fig. 7. Are you familiar with wooden building advantages?**

*Rys. 7. Czy znasz zalety budynków drewnianych?*



### Timber frame penthouse

Further results of the study indicate that only 13% of the respondents living in detached houses would have decided for a timber-framed penthouse, whilst 10% possibly would have decided on such a solution (fig. 8). The most common objection against a timber-framed penthouse was the concern about the combination of a brick-concrete building and wooden building in terms of quality and aesthetics, fire resistance, price, mechanical and technical properties and safety, and energy savings.



**Fig. 8. In case you need more living space, would you decide for a timber-framed penthouse?**

*Rys. 8. Gdybyś potrzebował więcej przestrzeni życiowej, to czy zdecydowałbyś się na nadbudówkę mieszkalną o drewnianej konstrukcji szkieletowej?*

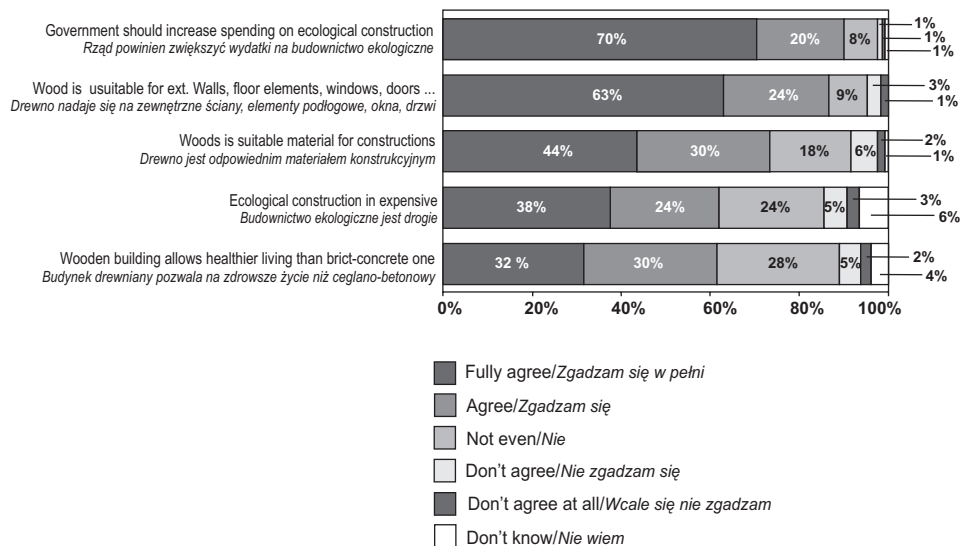
### Ecology and healthy living

The respondents also graded some statements considering wooden construction, the use of wood in general, ecology, and a healthy living environment. 70% of the respondents were in total agreement with the statement that the government should have allocated more funds towards ecological constructions. Most of them also agreed with the statement that wood was a good furniture making material (63% fully agreed with that statement) (fig. 9).

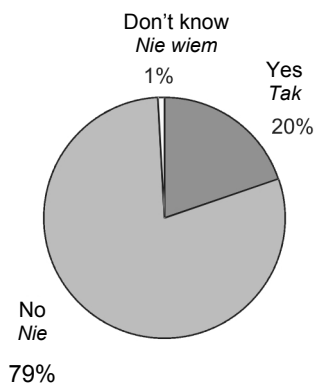
### Passive house

In recent years a number of low energy and ultra-low energy houses (PH) have been built. A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems [Feist 1988]. The house heats and cools itself, hence the name "passive". For European passive construction the prerequisite for this feature is an annual heating demand less than 15 kWh/(m<sup>2</sup>a), and this is not to be attained at the expense of an increase in the use of energy for other purposes (e.g. electricity). Furthermore, the combined primary energy consumption of the living area of a passive house may not

exceed 120 kWh/ (m<sup>2</sup>a) for heat, hot water, and household electricity. With this as a starting point, additional energy demands may be completely satisfied using renewable energy sources. We wanted to establish what the general public’s knowledge about low energy housing, i.e. passive house, was. The results of the public opinion survey showed the consumer’s lack of knowledge about passive house and its advantages (fig. 10).



**Fig. 9. Statements about wooden building, ecology and healthy living**  
**Rys. 9. Stwierdzenia dotyczące budynków drewnianych, ekologii i zdrowego życia**



**Fig. 10. Are you familiar with the passive house (PH)?**  
**Rys. 10. Czy wiesz co to są domy pasywne?**

According to the survey results the biggest advantages of PH were energy savings and environmentally friendly building. However some concerns about the price and quality performance were revealed as well.

## Discussion

Despite the small share of newly built wooden buildings in Slovenia, a positive trend can be observed indicating the rise of wooden building popularity. Since Slovenia has no tradition of wooden building, despite natural resources, the main reasons for that were investigated by the public opinion survey presented. The results show that people who would have chosen a brick-concrete construction, would have done so mainly because of old habits, tradition, and poor knowledge about wooden construction. Less than 47% of the respondents were familiar with the advantages of wooden construction: environmentally friendly material, energy conservation, short time of building, fire resistance, more living space etc. (fig. 7). We have assumed that the share of wooden constructions in Slovenia was so low due to the lack of knowledge about the properties of wooden constructions (either their advantages or disadvantages). We can now claim that our assumptions were correct.

65% of the Slovene population lives in detached houses (Product Group Manager 2005), which was also confirmed by our survey results. In one of the questions in the survey we asked the respondents if they would have chosen a timber-framed penthouse extension in case they had lived in a house and needed more living space. The minority answered “yes” or “maybe”. The most frequently given answers were reservations about the quality and aesthetics of combining classical construction with wooden. The respondents also stated that they thought ecological construction was more expensive, but on the other hand they admitted that it provided a healthier living environment. Most participants thought that wood was good furniture making material, but less appropriate for construction. Only 5% of the respondents were familiar with passive construction and they saw its advantages in energy efficiency and ecological construction. In the next 5 years we are expecting an increased demand for detached houses and according to research [Mandič 2005] we are also expecting an increase in wooden construction.

The research has confirmed that people are prepared to pay more money for a healthy living environment, especially in the case of bedroom and children’s room. Even the results of the *Emid* research (ProHOLZ Austria) indicate that 95% of the citizens think that wood creates a pleasant atmosphere and that they feel even better in rooms made of wood. The majority thinks that wood is part of the first three materials which assist in healthy living and agrees that its use should be increased, especially in residential construction. Furthermore, the

results of our research show that the majority agree that wood is suitable material for furniture and building structures; however, only a third of those asked would have decided on windows with wood frames. The reasons for that are especially the price, maintenance, and doubts about durability.

In conclusion, we can say that today's market for wooden construction reflects the present public opinion on wooden construction. The trend towards healthier living, increasing the use of natural resources and materials, and energy saving building has been identified. The main task in the future should be informing and educating the public about the advantages of wooden construction. We consider this public opinion survey a good starting point for a potential campaign for raising awareness about the subject of wooden construction in Slovenia.

This is why it is necessary to constantly recommend the undisputed comparative advantages of grown, renewable, and CO<sub>2</sub> neutral wood or wood products to politicians, society, individuals, and end users, emphasising the low content of grey energy and favourable analysis of the life cycle [Torelli 2008]. Stereotypical doubts about wood and wood products' structural characteristics, fire protection, durability, and aesthetic value are still present. Systematic education, professional assistance and shaping aesthetic and cultural values regarding wood construction are needed. Executed projects must be presented to the professionals and interested public, whilst good projects based on knowledge and innovativeness and their commercialisation must have precedence. It is necessary to carry out wooden construction projects, especially in the case of public buildings, i.e. kindergartens, schools, and multi-storey buildings, and increase among people awareness about the fact that wood is quality, cheap, and energy effective construction material, and thus increase the use of wood as a construction material to the level comparable with the rest of construction materials. The portal devoted to wood construction in Slovenia [www.lesena-gradnja.si; Kitek, Vratuša 2009] has been set up to inform the wider public about wood construction. The essential part of the portal presents a database of newly constructed wooden buildings (residential houses, public buildings, facades etc.) and database of professional articles. The articles concern the area of wood construction from the point of view of material (wood), the construction industry, and architecture. The authors of the articles are recognised professionals from the academia and business. The dynamics of the entries of buildings and articles in the LG e-catalogue is constantly growing (fig. 11, 12). The Internet portal was established and is supported by the University of Ljubljana (the Wood Science and Technology Department at the Biotechnical Faculty, the Faculty of Architecture, and the Faculty of Civil Engineering and Geodesy), the University of Maribor (the Faculty of Civil Engineering), the Chamber of Architecture and Spatial Planning of Slovenia, and the Slovenian Chamber of Engineers. The portal also allows co-operation between architects, engineers and

wood science practitioners who operate in isolation too often. New projects on wooden buildings as well as technical and professional papers are published weekly.

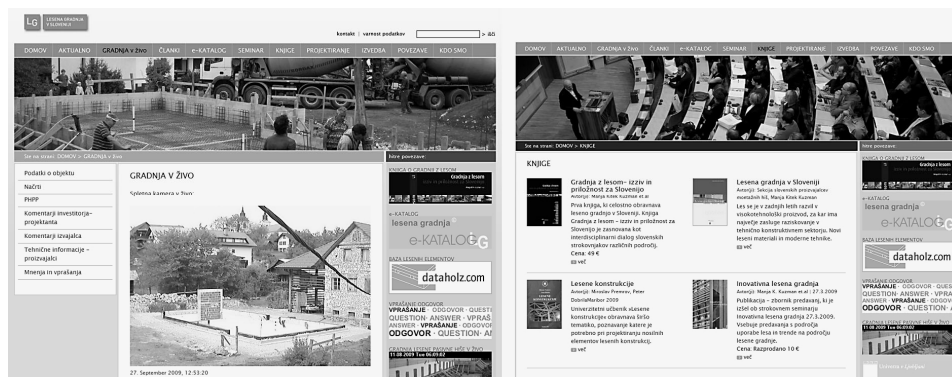


Fig. 11. Web portal www.lesena-gradnja.si  
 Rys. 11. Portal internetowy www.lesena-gradnja.si

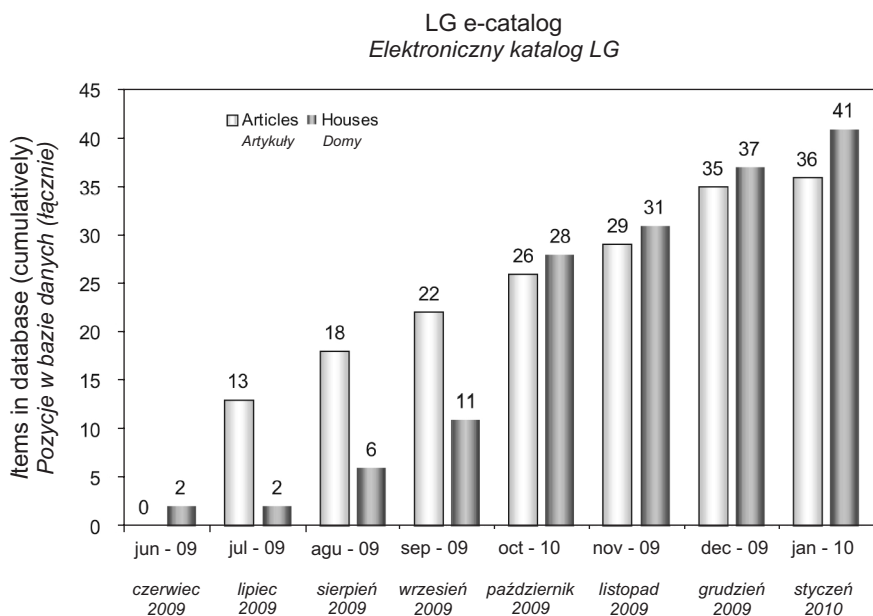


Fig. 12. The dynamics of the entries of buildings and articles in the LG e-catalogue  
 Rys. 12. Dynamika wpisów dotyczących budynków i artykułów w elektronicznym katalogu LG

With the intention of stimulating ecological construction the goal in the construction industry in the future will be to develop an evaluation of buildings with regard to their environmental-low emissions, economic – LCCC and social – health and safety – acceptability. Each building will have to be marked regarding how much energy was invested into its construction or how many CO<sub>2</sub> equivalents were freed during the construction, taking into consideration materials and technology.

Wood is a Slovenian national material with magnificent attributes and its use is a patriotic and environmentally friendly activity [Torelli 2008]. In Slovenia wood has already proven to be a traditional material in the national architecture and modern times set new challenges. In addition, development of science and technology has even made it possible to always use new methods in relation to this environmentally friendly and renewable material. Due to flooding of the market until 2025, a decrease in the construction of new apartment buildings is expected in Slovenia. Due to the need for reduction of energy consumption in buildings, a complete renovation of buildings [Novak 2008] is planned, hence there will be a great chance to renovate wood construction of the existing buildings. International guidelines also dictate a positive trend in wood construction, where wood construction is in great expansion and represents an important starting point not only for low-energy, but also for low-emission construction with exceptional prospects concerning health and security.

## Acknowledgments

This study was part of the Research Program “Lesarstvo” supported by the Ministry of Higher Education, Science and Technology of the Republic of Slovenia. The authors want to thank this agency and all study participants for their generous contribution of time and information.

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## OCENA WSPÓŁCZESNEGO SŁOWEŃSKIEGO BUDOWNICTWA DREWNIANEGO

### Streszczenie

Drewno w Słowenii jest dobrem naturalnym, którego zasoby nie są optymalnie wykorzystywane. Obecnie w Słowenii budynki wznoszone z wykorzystaniem drewna stanowią jedynie niewielki odsetek wszystkich budowanych obiektów. Jednocześnie kładzie się coraz większy nacisk na budownictwo energooszczędne i ekologiczne, zarówno na etapie powstawania budynków, jak i na etapie ich eksploatacji. Wykorzystanie drewna może wydatnie pomóc w uzyskaniu tego celu. W chwili obecnej można już zauważyć pozytywny trend zmierzający w tym kierunku.

Podstawą analiz w tej pracy było badanie opinii publicznej, które miało na celu znalezienie przyczyn obecnego stanu oraz pokazanie możliwości zwiększenia wykorzystania drewna w słoweńskim budownictwie w przyszłości. Zostało ono przeprowadzone w 2006 roku pośród ludzi będących potencjalnymi nabywcami nowych domów.

Pytania były podzielone na dwie kategorie. Pierwsza z nich dotyczyła wyboru technologii budowy nowego domu lub rozbudowy istniejącego. Druga kategoria to pytania sprawdzające wiedzę na temat właściwości drewna i zalet jego wykorzystania w budownictwie oraz świadomości ekologicznej w odniesieniu do konstrukcji drewnianych i domów pasywnych.

Na podstawie analizy zebranych odpowiedzi można stwierdzić, iż obecny poziom wykorzystania drewna w budownictwie znajduje odzwierciedlenie w opinii publicznej na temat konstrukcji drewnianych. To brak wiedzy o budownictwie drewnianym i jego zaletach oraz świadomości ekologicznej są znaczącymi przyczynami obecnego, niskiego poziomu wykorzystania drewna w budownictwie.

Przeprowadzone badanie opinii publicznej jest punktem wyjścia dla kampanii na rzecz poprawy świadomości Słoweńców w tym zakresie. Pierwszym elementem tych działań było uruchomienie portalu internetowego poświęconego budownictwu drewnianemu. Znajduje się tam baza danych o nowo budowanych obiektach drewnianych oraz artykuły, także naukowe, związane z tematyką budownictwa drewnianego.

**Słowa kluczowe:** drewno, zrównoważony rozwój, konstrukcje drewniane, opinia publiczna, budownictwo mieszkaniowe, strona internetowa, portal, Słowenia