Initiatives Supporting Timber Constructions in Finland, Slovenia and Sweden
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Abstract

Finland, Slovenia and Sweden are the three most forested countries in the European Union. While Finland and Sweden have a long tradition of building with wood, most housing in Slovenia were made with brick and stone. In Finland, knowledge of wood, an age-old building material, is actively preserved and enhanced. New wood buildings gain a contemporary twist, and are a significant part of the building stock in Finland. Swedish long tradition with timber construction is going from strength to strength thanks to the development of advanced, modern day timber structures. Sweden’s national building code has allowed the construction of multi-storey timber housing since the mid1990s. Builders and architects know that timber is not only an economical building material but that it has the added bonus of being climate friendly. Though few in number, most Slovenian timber buildings combine contemporary styling with energy efficiency measures that bring them close to passive house standards. Slovenia’s construction industry is widely recognized as advanced in the field of low energy buildings. As energy-efficient building methods gain importance, timber passive houses can play an increasingly important role in the future. In this paper, the Finnish, Slovenian and Swedish initiatives and legalization supporting timber constructions will be presented in relation to current European regulations with an emphasis on the use of wood as a sustainable architectural construction material for the future.

Keywords: timber construction, architecture, legalizations, Sweden, Finland, Slovenia
1. Introduction

Globally, the construction sector is the most important branch of industry affecting the development of sawmill industry and further income received by the forest owners (Bumgardner et al., 2013; Männistö et al., 2012). Finland, Slovenia, and Sweden are the three most forested countries in the European Union (Figure 1). Wood industry is among the most important industrial sectors in all countries. Wood sector is a part of the national strategy plans and one of the industrial branches considered national economy boosters. Forests cover 77% of Finland’s surface area, and wood is an important renewable natural resource for the country. Although the most of the forests are owned by non-industrial private forest owners (NIPF), and Finland has living traditions in wood construction especially in single-family houses and summerhouses, its wood usage can be considerably further increased. Forests are also an important natural resource in Slovenia protecting biodiversity and playing an important role in the conservation of the Slovenian natural heritage. Almost 50% of all Slovenian forests are parts of Natura 2000 sites. The forested land has expanded from 35% to almost 62% in a matter of decades. Sweden is the third largest country by area in Europe, and 69% of it is forest with a similar NIPF dominated forest ownership structure as in Finland. Sweden has a long tradition of sustainable forestry and industrial refining of the raw material which forestry can provide. Swedish long tradition with timber construction is going from strength to strength thanks to the development of advanced, modern day timber structures (Table 1).

![Figure 1. Forest area in percentage of total land area (http://data.worldbank.org/indicator/AG.LND.FRST.ZS)](http://data.worldbank.org/indicator/AG.LND.FRST.ZS)

<table>
<thead>
<tr>
<th></th>
<th>Finland*</th>
<th>Slovenia**</th>
<th>Sweden***</th>
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<tbody>
<tr>
<td>Surface area of forested land (ha)</td>
<td>26.2 · 10^6</td>
<td>1.18 · 10^6</td>
<td>28.1 · 10^6</td>
</tr>
<tr>
<td>Forested area (%)</td>
<td>78</td>
<td>62</td>
<td>69</td>
</tr>
<tr>
<td>Number of naturally occurring tree species</td>
<td>30</td>
<td>71</td>
<td>26</td>
</tr>
<tr>
<td>Growing stock (m^3)</td>
<td>2,300 · 10^6</td>
<td>346 · 10^6</td>
<td>3,400 · 10^6</td>
</tr>
<tr>
<td>Annual growth of growing stock (m^3/forest)</td>
<td>106 · 10^6</td>
<td>8.59 · 10^6</td>
<td>112 · 10^6</td>
</tr>
<tr>
<td>Annual harvest (m^3 forest)</td>
<td>68 · 10^6</td>
<td>6.19 · 10^6</td>
<td>92 · 10^6</td>
</tr>
<tr>
<td>Hardwoods (m^3)</td>
<td>14.5 · 10^6</td>
<td>3.35 · 10^6</td>
<td>10 · 10^6</td>
</tr>
<tr>
<td>Softwoods (m^3)</td>
<td>53.5 · 10^6</td>
<td>2.84 · 10^6</td>
<td>82 · 10^6</td>
</tr>
<tr>
<td>Sawn wood consumption per capita (m^3/year), 1997–2012 average</td>
<td>0.8</td>
<td>0.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

1 In Finland, sawn wood consumption per capita in 2012.

Use of wood in sustainable buildings in Finland, Slovenia and Sweden

In Finland, the usage of timber in buildings is most common in single-family houses (80% of the buildings made with timber frames) and row houses (60% of the buildings made with timber frames), while utilization of wooden structures, for example, in multi-storey houses and public buildings is still at the development stage (Figure 2). Thus, as there is notable renewal potential especially in the timber multi-storey and public building markets, strong emphasis have been put to enhance the development potential of timber construction business since 1990s by, e.g., removing regulative barriers and enhancing business development of wood construction companies (see, e.g. Hurmekoski et al., 2015; Toppinen et al., 2016).

NB. Multi-storey buildings

Figure 2. Usage of wood in Finnish buildings (mod. from Finnish Forest Industries Federation, 2010).
In Slovenia, residential buildings represent the biggest share (47%) of the existing buildings. More than half of them are made of brick (56%), 16% of concrete and mixed construction, and the rest made of materials including timber are represented to a smaller extent. Focusing to the Slovenian timber construction, current rise has been noticed, even though the percentage of new timber buildings in Slovenia is still small regarding the entire new construction, especially in the public buildings sector and in multi-storey buildings. In 2014 (SORS), the percentage of newly built pre-fabricated houses, mostly one or two-family, exceeded 15% and the percentage is expected to increase to 20-30% over the next five years. The dominating methods of timber construction in Slovenia include a timber-frame construction, timber panel construction and mass timber (Kitek Kuzman et al., 2014). Slovenia’s construction industry is widely recognized as advanced in the field of low energy buildings and timber passive houses which will play an increasingly important role in the future.

In contrast to multi-storey housing, the industrial manufacture of single-family timber housing has a long tradition in Sweden. For several decades, about 90% of the on-site and prefabricated single-family houses built in Sweden have timber-frame systems. In Sweden, it was not possible to use timber as a frame material in the construction of houses with more than two storeys until 1995. Today, the use of timber as a material in multi-storey housing has increased to approximately 15% of all newly built multi-storey buildings. Developments towards an industrialised construction and manufacture within the timber building sector have in recent years led to an increase in prefabricated structural components of solid wood, engineered wood products, and non-wood materials that are assembled at the construction site. The main timber-construction principles are the same in Sweden as they are in Finland and Slovenia.

Table 2 identifies the key differences in timber constructions in Finland, Slovenia and Sweden.

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<th>Finland</th>
<th>Slovenia</th>
<th>Sweden</th>
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<tbody>
<tr>
<td>Share of detached houses in residential construction [%]</td>
<td>38</td>
<td>40</td>
<td>39</td>
</tr>
<tr>
<td>Market share of wood in detached houses [%]</td>
<td>80-90</td>
<td>15</td>
<td>80-90</td>
</tr>
<tr>
<td>Market share of new multi-story timber buildings</td>
<td>4</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Maximum number of storeys allowed from timber, with sprinklers, in 2014 (since 2011)</td>
<td>8</td>
<td>≤ 5</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Key multi-story construction techniques in timber</td>
<td>Timber-frame</td>
<td>Timber-panel</td>
<td>Module</td>
</tr>
<tr>
<td></td>
<td>Timber-panel</td>
<td>Mass-timber</td>
<td>Module</td>
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<td></td>
<td>Module</td>
<td>Mass-timber</td>
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This paper will give the current situation in promotional activities of wood sector, since timber construction and the use of wood products have two key positive environmental and climatic effects, in Finland, Slovenia and Sweden and demonstrate the existing differences among given countries as well as possible improvements.

1.4 Legislations Supporting Timber Construction
European Policy is affecting and, indeed, directing current research, development, and marketing in the European Union (EU). Many policy strategies and actions directly impact the forest product industry. The main policies with direct impacts on the forest-based sector are the EU Sustainable Development Strategy (SDS, Mainstreaming sustainable development into EU
policies: 2009, 2009), which was published in 2006, and reviewed in 2009, the EU Roadmap 2050 (European Commission (2011), and the recycling society directive (Directive 2008/98/EC, (Directive 2008/98/EC, 2009). Additionally, with the support of the EU Commission, industry stakeholders created the Forest-based Sector Technology Platform (FTP). This group produced FTP Vision 2030 (Horizons - Vision 2030 for the European Forest-based, 2013; Strategic Research and Innovation Agenda for 2020, 2013) which is a strategy guide for the forest-based sector to help achieve the EU’s goals of sustainable, inclusive growth.

The SDS sets out a single, coherent strategy on how the EU will more effectively live up to its long-standing commitment to meet the challenges of sustainable development. It recognizes the need to gradually change our current unsustainable consumption and production patterns and move toward a more integrated approach to policy-making. It reaffirms the need for global solidarity and recognizes the importance of strengthening our work with partners outside the EU, including rapidly developing countries, which are expected to significantly impact global sustainable development. The overall intent of the SDS is to identify and develop actions to enable the EU to achieve continuous long-term improvement of quality of life.

Specifically, the SDS calls for the creation of sustainable communities able to manage and use resources efficiently, able to tap the ecological and social innovation potential of the economy, and in the end are able to enjoy prosperity, environmental protection, and social cohesion.

The Roadmap 2050 project mission is to provide a practical, independent, and objective analysis of pathways to achieve a low-carbon economy in Europe, which promotes energy security as well as the environmental and economic goals of the European Union. The Roadmap 2050 project is an initiative of the European Climate Foundation (ECF) and has been developed by a consortium of experts funded by the ECF. Roadmap 2050 breaks new ground by outlining plausible ways to achieve an 80 % reduction in greenhouse gas emissions from a broad European perspective, based on the best available facts elicited from industry members and academia, and developed by a team of recognized experts rigorously applying established industry standards. Roadmap 2050 determines five priorities that must be established between 2010 and 2015 in order for Europe to progress toward implementation of an 80 % reduction in target for greenhouse gas emissions by 2050:

1. Energy efficiency (through aggressive energy efficiency measures in buildings, industry, transport, power generation, agriculture, etc.);
2. Low carbon technology (development and deployment of, offshore wind, biomass, electric vehicles, fuel cells, integrated heat pump and thermal storage systems, and networked high-voltage, direct current (HVDC) technologies, including adoption of common standards, etc.);
3. Advanced electricity grids and integrated market operation (i.e., increase in regional integration and interconnection of electricity markets; effective transmission and distribution regulation, the development of regionally integrated approaches to planning and operation of grids and markets);
4. Fuel shift in transport and buildings (fossil fuels are replaced in the building and transport sectors by decarbonized electricity and low CO2 fuels (e.g., second generation biofuels);
5. Markets (a massive and sustained mobilization of investment into commercial low-carbon technologies).

The listed policy strategies and actions are affecting Finish, Slovenian and Swedish research and development in the field of wood science and timber architecture.
2. Promotion of wood use in Finland, Slovenia and Sweden

The Indufor (2004) study made a detail analysis of activities to promote use of wood in Europe. Individual companies, regional industry associations, national (mostly in Western Europe) and international organizations (e.g. proHolz-A, Danish Wood Information Council-D, Comte National pour le development du Bois-F, Promo_legno-I, Lignum-Ch,…) implement activities to promote use of wood.

The erstwhile Nordic Timber Council (NTC), which closed its operation in 2006, was one of the leading organizations in this endeavor. It initiated the “Building Europe” campaign to enhance the use of wood in construction. It circulated the “Building Europe - European Wood Magazine” in France, Germany, The Netherlands, UK, Finland, Sweden, and Norway to inspire and educate architects to use and work with wood. NTC also set up the “Environment Communication Platform” to promote the environmental advantages of wood.

CEI-Bois is implementing several action plans to achieve the vision of making wood one of the leading construction material in Europe. Concrete actions are focused around standardization and Eurocodes, knowledge base, education and training, construction process, and new markets.

Table 3 illustrates organizations promoting wood at European and national levels from Slovenia, Sweden and Finland. As, for example, in Finland there are many industries connected to the wood construction, some of them are as a part of their work also promoting the use of wood in building and thus the list is not exhaustive.

The organizations promoting wood at European and national levels is illustrated in Table 3.

<table>
<thead>
<tr>
<th>Organizations promoting wood at European and national levels</th>
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<tbody>
<tr>
<td><strong>European Level</strong></td>
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<tr>
<td>Forest-based Sector Technology Platform (FTP), <a href="http://www.forestplatform.org">http://www.forestplatform.org</a></td>
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<tr>
<td>UNECE/FAO (Team of Public Relation Specialists in Forestry), <a href="http://www.unece.org/forests/welcome.html">http://www.unece.org/forests/welcome.html</a></td>
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<tr>
<td>European Commission Enhanced Use of Wood Working Group</td>
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<tr>
<td>Nordic Wood Council (Norway, Finland, Sweden) which closed its operation in 2006</td>
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<tr>
<td>and European Wood Councils,</td>
</tr>
<tr>
<td>The European Timber Trade Federation, <a href="http://www.ettf.info/">http://www.ettf.info/</a></td>
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<tr>
<td><strong>Finland</strong></td>
</tr>
<tr>
<td>Puutuoteteeollisuus ry, <a href="http://puutuoteteeollisuus.fi/">http://puutuoteteeollisuus.fi/</a></td>
</tr>
<tr>
<td>Finnish Forest Industries Federation, <a href="https://www.finlandforschung.org/">https://www.finlandforschung.org/</a></td>
</tr>
<tr>
<td><strong>Slovenia</strong></td>
</tr>
<tr>
<td>The Furniture and Wood-Processing Industry Association, <a href="https://www.gzs.si/zdruzaj_elesne_in_pohistvene_industrije">https://www.gzs.si/zdruzaj_elesne_in_pohistvene_industrije</a></td>
</tr>
<tr>
<td>Wood Industry Cluster, <a href="http://www.lesarski-grozd.si">www.lesarski-grozd.si</a></td>
</tr>
<tr>
<td><strong>Sweden</strong></td>
</tr>
<tr>
<td>Trästad Sverige/Wood City Sweden, <a href="http://www.trastad.se">http://www.trastad.se</a></td>
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</table>
Attitudes towards timber construction vary between Finland, Slovenia and Sweden even though that timber construction offer competitive solutions for more sustainable construction. Increasing the use of renewable materials, mainly wood, in buildings, could make construction more sustainable and a part of bio-economy (Riala and Ilola, 2014). There are in all countries considerable activities, initiatives and legalization supporting timber constructions in relation to current European regulations with an emphasis on the use of wood as a sustainable architectural construction material for the future.

2.1. Finland

Finnish Bio-economy Strategy

Finland has set the course for a low-carbon and resource-efficient society and a sustainable economy. A key role in reaching this goal is played by a sustainable bio-economy. Thanks to plentiful renewable natural resources, high level of expertise and industrial strengths, Finland is excellently placed to become a pioneer of the bio-economy in the world. The vision of the first Finnish Bio-economy Strategy is that Finnish well-being and competitiveness will be based on sustainable bio-economy solutions.

The objective of the Finnish Bio-economy Strategy is to generate new economic growth and new jobs from an increase in the bio-economy business and from high added value products and services while securing the operating conditions for the nature’s ecosystems. The leading idea of the strategy is that competitive and sustainable bio-economy solutions for global problems will be created in Finland, and that new business will be generated both in the Finnish and international market, thus boosting the welfare of the whole of Finland.

In Finland, the overall initiatives to enhance usage of wood in construction is closely connected to the endeavours fulfil global and international objectives of sustainable development and enhance competitiveness of Finnish forest sector with a critical importance for the national economy.

The objective of the Finnish Bio-economy Strategy is to generate new economic growth and new jobs from an increase in the bio-economy business and from high added value products and services while securing the operating conditions for the nature’s ecosystems. The leading idea of the strategy is that competitive and sustainable bio-economy solutions for global problems will be created in Finland, and that new business will be generated both in the Finnish and international market, thus boosting the welfare of the whole of Finland.

The Bio-economy Strategy was drafted in a project set up by the Ministry of Employment and the Economy. Participants in this project were the Prime Minister's Office, the Ministry of Agriculture and Forestry, the Ministry of the Environment, the Ministry of Education and Culture, the Ministry of Social Affairs and Health, the Ministry of Finance, the administrative branches under these Ministries, as well as VTT Technical Research Centre of Finland and the Finnish Innovation Fund Sitra. Stakeholders representing the bio-economy also gave their inputs to strategy preparation. They were consulted in five workshops, three regional bio-economy forums and sectoral consultations. The strategic goals of the Bio-economy Strategy are: 1. A competitive operating environment for the bio-economy, 2. New business from the bio-economy, 3. A strong bio-economy competence base, 4. Accessibility and sustainability of biomasses (Sustainable growth from bio-economy - The Finnish bio-economy strategy, 2014).
National wood construction programme 2011–2015

In Finland the Ministry of Employment and the Economy has headed a National Wood Construction Programme under the Strategic Programme for the Forest Sector, for 2011–2015. The goal of the wood construction programme is to diminish the carbon footprint of construction by significantly increasing the use of domestic wood in construction. The aim is to make Finnish wood construction an international brand by combining good architecture and design with environmentally conscious and energy-efficient building with intelligent building (Status and possibilities of wood construction in Finland, 2015). In addition, since August 2016 in Finland there has been “an official advocate of wood construction” working in the Ministry of Environment. His task is to promote wood construction as part of one of the government’s key projects and the development of industrial wood construction expertise. Nowadays have new materials, industrial solutions and industrial prefabrication taken wood construction to a completely new level since the first projects in the late 1990s.

In Finland, there were many promotion campaigns and technology platforms in the 1990s, aiming to facilitate the diffusion of wood-based construction. Two different strategies have been used in promoting timber construction: (1) Concept of modern wooden cities and (2) promotion the construction of wooden multi-storey apartments and office buildings (Riala and Ilola, 2014).

Concept of modern wooden cities

The first utilized the concept of modern wooden cities, and took inspiration from the older areas of some Finnish towns, for example, from Porvoo, and the dense terraced housing common, for instance, in the UK. The idea was to build single-family houses, which are popular in Finland, while combatting urban sprawl. This project was operational from 1997 to 2013, and resulted in 20 completed projects, ranging in size from five houses to areas consisting of several blocks of buildings (Puuinfo 2013).

The modern wooden town is a new generation of high-density and efficiently built enjoyable residential areas of wooden houses (Heikkinen, 2005). The aims of a modern wooden town are: human scale, uniform environment with variation giving identity to dwelling, combination of the living properties chosen of both high rise living and individual dwelling in detached houses, creating different privacy levels of exterior areas starting from private yard ending up to common urban areas, finishing the area in building phase at one time mainly by one contractor, scattered structure of different housing typologies from detached houses to small block of flats, varied sizes of apartments (Figure 3a, 3b).

Figure 3a. Wood town of Lehtovuori: This area’s blocks consist of three village-like units that have their own structure with its low-speed residential roads, lanes, yards and open spaces. The blocks are built from detached and semi-detached houses as well as back-to-back semi-detached houses, whose variation, in addition to the views that peel out from between the buildings, creates a special scale for the environment. (http://www.woodarchitecture.fi/projects/lehtovuori-area)
Promotion the construction of wooden multi-storey apartments and office buildings using domestic Finnish wood resources.

The rapid diffusion of wood multy-storey constructions (WMC) in Finland is the result of several factors; in 2011 the Finnish Government set a target of increasing the market share of WMC from 1% in 2011 to 10% by 2015, in pursuance of environmental and economic benefits through promoting the use of domestic wood resources. Subsequently, fire regulations were revised to allow WMC up to eight stories. These changes seemingly encouraged large forest industry firms to establish alliances with construction companies to develop novel WMC techniques. The investments of large players have increased the credibility of WMC. Finally, the investments, vertical co-operation (within the value chain), as well as increased competition have begun to lower the costs of WMC compared to rivalling practices, while also being able to solve the technical issues encountered in the experimental phase.

The construction of multi-storey timber buildings has required many technical advances, for example, development of better sound insulation between floors (Tekes, 2000). So far 37 residential multi-storey timber buildings and four office buildings have been completed in Finland. All of the office buildings are for forestry related organisations (Puuinfo, 2014) (Figure 4).

The Finnish Timber Council - Puuinfo

In Finland, Puuinfo Oy and Building Information Ltd. are working actively in the field of wood construction. Puuinfo seeks to promote the use of wood in construction and interior
design to create demand for wood products. It disseminates impartial and readable research findings on uses of wood and serves as an information channel for enterprises in the wood products industry. Puuinfo mainly operates domestically but has some international services such as PUUWOODHOLZBOIS magazine and web publication together with the Mobile Wood Architecture guide application. The shareholders of Puuinfo are Finnish Forest Industries Federation, Finnish Sawmills, The Association of the Finnish timber and builders’ merchants and the The Central Union of Agricultural Producers and Forest Owners (MTK). Puuinfo Oy is a non-profit company, potential profit will be allocated to develop better Puuinfo services (Figure 5).

Web page WOODARCHITECTURE
WOODARCHITECTURE.fi presents high quality Finnish wood architecture and wood construction solutions. The aim is to raise the international awareness of Finnish design and wood working industries and create new opportunities for them. The selected projects have been published in the printed Wood-magazine. On top of the printed magazine web publication presents architect offices and gives essential product and supplier information to help readers to locate the architects and suppliers. http://www.woodarchitecture.fi (Figure 5).

Figure 5. Puuinfo Oy and Building Information Ltd.

Figure 6. WOODARCHITECTURE.fi

2.2. Slovenia
The latest European policy strategies and actions are affecting Slovenian research and development in the field of wood science and timber architecture. In 2008, the Slovenian Government adopted the National Energy Efficiency Action Plan 2008–2016 (National Energy Efficiency Action Plan 2008), the objective of which, in accordance with Directive 2006/32/EC, is to achieve a 9% saving of end-use energy through the implementation of planned instruments, which cover measures for efficient energy consumption, energy services, and the development of energy-efficient technologies and products.
In 2008, in accordance with directives of the European Parliament and Council (EPBD) 2002/91/EC (2002) and EPBD 2010/31/EU (2010), Slovenia adopted the national construction legislation “Rules on efficient use of energy in buildings”, which were amended and republished in 2010 (Official Gazette RS, 2009). The rules lay down the minimum technical requirements and guidelines for constructing low-energy houses today, where the energy

Consumption for heating today is approximately 40-50 kWh/(m²a) and will in future be nearly zero.

**Green Public Procurements**

Green public procurement in the construction sector in Slovenia is primarily affected and regulated by the technical specifications and criteria for buildings as specified in Annex 7 of the Decree Amending the Decree on Green Public Procurement (Decree on Green Public procurement 2011). In the category of buildings, it is generally required that 30% of in-built material (by volume) must be timber or timber-based (50% of this can be substituted by products with EcoLabels I or III). Furthermore, an award criterion gives additional credit if the 30% minimum threshold for in-built material is exceeded.

**Economic incitements for timber buildings/constructions**

Like several other European countries, Slovenia is increasing the energy performance of buildings by encouraging investors or buyers to select more energy-efficient technologies through measures that make them more price-competitive, e.g. through low-interest loans or subsidies. In Slovenia, investors can receive low interest rate loans to build passive and very low-energy houses. Nowadays most timber houses built in Slovenia meet the requirements of the international Passive house Standard. The reason is that timber building manufacturers have a high knowledge level and tradition within this technology. Furthermore, lower interest-rate loans are also offered by the Slovenian Environmental Public Fund. These loans are intended for the construction or renovation of passive or very low-energy houses or for energy-efficiency measures (installation and replacement of solar collectors, biomass boilers, heat pumps, ventilation with recuperation, external building fixtures, heat insulation of the façade and roof) and for changing old windows with high quality wooden energy-efficient windows. From 2008 to 2011 the Slovenian Environmental Public Fund allocated EUR 21,832,400 in loans and this led to savings of about 85,000 MWh in energy and about 13,000 tons of CO₂.

Subsidies from the National Energy Efficiency Action Plan 2008-2016 (National Energy Efficiency Action Plan 2008) also provide support for energy efficiency. These subsidies are available to those undertaking measures to improve energy efficiency, including the construction of passive and very low-energy houses and the comprehensive renovation of existing residential buildings. The subsidies have led to a significant increase in the number of passive timber houses and very low-energy timber houses in Slovenia (Praznik and Zbašnik-Senegačnik 2007). The level of subsidies depends on the energy class of the renovated or newly built house and the type of heat insulation material. The highest subsidy, EUR 125 per square metre of heated area, can be allocated for the construction of a residence in the lowest energy class [less than 10 kWh/(m²a)], insulated to at least 75% using material of natural origin (e.g., cellulose flakes, wood fibre, etc.). Subsidies are available for a maximum of 200 m² of net heated area in the building. With optimal construction design and components, the subsidies may entirely cover the price difference between a passive timber house and a house built to the currently valid regulations - the Active House based on the active house concept, this highly energy-efficient structure makes best use of solar energy and offers utmost living comfort (Figure 7).
Figure 7. The house is built entirely of environmentally-friendly materials, which have the biggest impact on the environment in the stage of production. The house includes a photovoltaic power station, solar collectors for hot water, skylights, rainwater gathering for sanitary purposes and watering as well as smart installations.

**Award for wood construction**

The first National award for wood construction in Slovenia was presented in 2013 and the winners were selected by an interdisciplinary committee that included two architects, one expert from the field of sustainable construction and efficient energy use, one civil engineer and one expert from the carpentry sector. There were awards in four categories: residential buildings, public buildings, business-industrial buildings, and engineering works and technical solutions. There was also a special award from the committee for achievements in the field of technical solutions. This awards event seeks to promote the positive image of wood, strengthen awareness about wood and encourage the use of wood both in construction and in everyday use (Figure 8).

Figure 8. The nominated for the Slovenian Timber Prize 2016: (a) The facilities in the Škocjanski zatok Natural reserve, (b) Wooden House.

**Other activities for wood promotion in Slovenia**

The national action plan “Wood is beautiful” includes promotional activities that directly improve the state of the Slovenian wood-processing industry and improve the Slovenian transition to a low-carbon society.

SPIRIT Slovenia – Public Agency for Entrepreneurship, Internationalization, Foreign Investments and Technology continues in 2017 to work on the promotion of wood and wood products with the aim to enhance the general awareness of wood and to encourage the use of wood in building construction, as well as to inform the public about many structural advantages of wood during construction, its positive effects on the micro-climate within the building, the fact that it is a sustainable and renewable building material, and social responsibility in balancing environmental, social and economic values.
Ljubljana- European green capital 2016- The first and only green oasis in central and south Eastern Europe. Numerous changes have happened in a short period, which is one of the reasons why Ljubljana has become European Green Capital 2016. Ljubljana has 542 square meters of public green space per resident, while the city features 80 hectares of newly maintained green spaces, and green spaces are still being created from degraded urban land. Wood has a very special character in Ljubljana’s green projects with a focus on the green city of tomorrow. Some showcase projects has been built as a dialog, showing that wood is the material of the future in urban construction and living, which will contribute in an essential way to new, cleaner and more healthful building practices (Figure 9).

![Figure 9. Ljubljana - European green capital 2016: Pavilion ZPE- the compact and mobile exhibition element demonstrates the technological, design and environmental potentials of building with wood.](image)

2.3. Sweden

In Sweden, a national strategy for “more wood in construction” was implemented in 2004, striving to further develop industrialized production processes (Platen and Nord, 2004). The vision of this strategy was that wood would be a self-evident material alternative in all construction work in Sweden within 10 to 15 years, and at a somewhat later date even in Europe. To reach this goal, operationalized objectives were formulated as follows:

- Increased competition in terms of construction materials and techniques. More choice alternatives will increase the competition on the market, and this can lead to decreasing costs and better products.
- The provision of new jobs by increasing the extent of further processing of wood as a raw material.
- A decrease in construction defects due to a greater degree of industrialized prefabrication. This has the advantage that construction elements can be built indoors, which leads to improved construction conditions for the product and a better work environment for the employees, which will improve quality control.
- Environmental protection by sustainable construction. Substituting steel and concrete with wood will reduce CO₂ emissions considerably.
- Giving wood the chance to catch up with other construction materials that were treated preferentially due to the prohibition of wood in certain constructions.

In Sweden, there is a wide range of programs to promote multi-storey wooden buildings.

**Swedish National timber Construction Strategy**

In 2006, the Swedish government appointed a National Timber Construction Strategy Committee, with the primary task of promoting the use of wood in apartment houses and public buildings. It is based on analyses carried out by the Swedish Ministry of Enterprise, Energy and Communications. A number of measures have been implemented within the framework of the strategy, including continuing training for those actively involved in the construction sector and
“initiative projects” involving the construction of multi-storey buildings in the towns of Växjö, Falun and Skellefteå. In addition, joint action projects have resulted in the construction of buildings in several locations. In parallel with this, the timber industry is taking action through the Swedish Wood Construction Council. The two organisations have held a number of seminars and inspirational days throughout Sweden.

The National Timber Construction Strategy came to an end in December 2008. It is, however, continuing to operate under the name Wood City 2012, a project which will involve further municipalities and regions. The Continuing Training Programme has been implemented jointly by Luleå University of Technology, Linnaeus University, University College Dalarna and RISE - Research Institutes of Sweden. This programme has been carried out in close collaboration with major wood construction projects in Skellefteå, Falun and Växjö, for the purpose of:

- monitoring and recording several aspects of timber construction projects, including residential quality, planning and decision,
- making process, technical/functional solutions, aesthetic aspects, the environment and life cycle targets, management and life-cycle economy, as well as timber system suppliers,
- making presentations and drawing conclusions at seminars held in connection with the construction project and at specialist workshops,
- ensuring the availability of records and information,
- providing a natural link with education and research at universities and institutes,
- creating the basis for the development of strong supplier groups in the wood construction sector (Bengtsson et al 2009) (Figure 10).

![Figure 10](image)

**Figure 10.** (a) Residential building Skagershuset, Stockholm: 3 floors, 2012-13, (b) Strandparken, House B, Årsta, Stockholm: 8 floors, 2013

**Nordic Wooden Cities**

The project “Nordic Wooden Cities” must also be mentioned. This project links together Sweden, Denmark, Norway, Finland and Iceland in a cooperation aiming at developing modern wooden cities. Wood should play a more central role in urban development in all kinds of buildings. A close collaboration on the political and administrative levels, information sharing, sharing of “best practice” experience in the whole range of the building process, innovation promoting and supporting cooperation between the public and private sectors are of utmost importance for the Nordic delegates involved in this project. Today, 17 members are engaged in “Nordic Wooden Cities”, and new members are welcome to join (Nordic Wooden Cities, 2010).

A similar approach has been successfully implemented in the “Välle broar” project in the municipality of Växjö, by the project coordinator Hans Andrén; where the public sector, industry and academia have a common ambition to lift timber construction to the next level. All
three sectors have a common denominator in triggering the use of timber in construction and
the understanding that no sector can do everything on its own but that there is considerable
benefit if the sectors work together. In that way, timber construction can be lifted to a higher
level (Figure 11).

Figure 11. Close cooperation between Växjö Municipality, academic institutions, trade and industry is essential
in order to realise ambitions of increasing the use of wood in modern construction projects. The climate issue is a
strong mutual interest that links these different players. Close cooperation creates new opportunities for industry,
for example by stimulating the development of new products and techniques.

Award for timber construction
The Architecture in Wood Prize is one of Sweden’s biggest and most important architectural
competitions, presented every four years to a building that represents good architecture in wood
and that reflects and improves the times in which we live. The winner of the prize 2016 was the
12th winner since 1967, when it was established by the Swedish Forest Industries Federation (Figure 12).

Figure 12. The Nominated for the Swedish Timber Prize 2016: (a) Mölle House, (b) Emils Backe House, (c)
Strandparken (http://www.swedishwood.com/about_us/news/2015/11/the_nominated_for_the_swedish_timber_prize_2016/)

3. Conclusion

Attitudes towards timber construction vary between Finland, Slovenia and Sweden even
though that timber construction offer competitive solutions for more sustainable construction.
There are in all countries considerable activities, initiatives and legalization supporting timber
constructions in relation to current European regulations with an emphasis on the use of wood as a sustainable architectural construction material for the future.

It seems that the wood construction system in Sweden and Finland is passing from a formative to a growth phase, while in Slovenia it is still in the formative phase. Single-family wooden housing has a long tradition in all countries, but it is more dominant in Sweden and Finland than in Slovenia.

The rise of wooden multi-storey construction in the Nordic countries has turned out to be the most evident construction-related new business opportunity in the emerging bio-economy (Toppinen et al., 2017). After a long period of multi-story apartment building construction in Finland that has depended on concrete element technology, it is time to awaken to see the possibilities offered by closely-spaced, low-slung housing construction. Closely-spaced, small-scale timber construction is traditional and valued in all the Scandinavian countries. Timber for multi-storey building structures has a market share of about 15% in Sweden and in Finland, but is almost non-existent in Slovenia.

Acknowledgements

The authors would like to thank the STSM COST FP1407 and Slovenian Research Agency for financial support within the P4-0015 program. Financial support from the Swedish Research Council Formas (projects EnWoBio 2014-172 and Experimental studies of capillary phenomena in bio-based materials 942-2016-64) is also gratefully acknowledged.

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