

Wooden house construction in Scandinavia – a model for Europe

Holzhausbau in Skandinavien – Vorbild für Europa

Construction de maisons en bois en Scandinavie –
un exemple pour l'Europe

Costruzione di case in legno in Scandinavia –
modello per l'Europa

Tobias Schauerte
Associate Professor Industrial Engineering, ek. Dr.
Linnaeus University, School of Engineering
Växjö, Sweden



Wooden house construction in Scandinavia – a model for Europe

This paper is aiming at describing selected areas of wooden house construction in Scandinavia, in order to show, whether or not these areas might be of referent power for other parts of Europe.

The term *Scandinavia* might be misleading to the attentive reader, since the countries of interest for the present paper are not limited to the countries in the particular geographical meaning of the Scandinavian peninsula, i.e. Norway and Sweden. Here and as often associated in a broader habitual linguistic meaning, Denmark and Finland are included as well.

To give an overview of wooden house constructions in these countries, it is distinguished between the markets for single family houses on the one hand and multistory houses on the other hand. In the chapter on multistory houses, strategies and concepts aiming at triggering wood in construction are presented as well, as these to a large extent, and some of them almost exclusively, are designated for multistory houses in wood.

1. Single family houses

Looking at the market for single family houses in Scandinavia, it becomes obvious that wooden houses have least market share in Denmark. Even though building starts of wooden houses are increasing in Denmark, their market share just exceeded 10% (USDA, 2006; Lavoie, 2008). In Norway, Sweden and Finland, the market share of wooden houses accounts for approximately 90% (Thelandersson et al., 2004, Paper and Wood Insights, 2010).

These numbers show that the choice of building material in Norway, Sweden and Finland literally seen is a natural one, since the raw material wood is highly accessible in these countries, compared to Denmark. Ready availability of wood contributed to cost effective usages, which can explain the long tradition of high utilization of wood in the construction sector. Prefabrication efforts can e.g. be traced back to the 1780s in Sweden (Waern, 2008) and the late 1800s in Norway (Schmidt, 2009), and were continuously developed further on. Yet, the information that wood is the dominating building material in Norway, Sweden and Finland is not primarily interesting in and of itself. Notably is the fact that these cultures were able to perfect production methods for prefabricated wooden houses (Smith, 2009).

In Sweden, indefensible housing conditions triggered the exploitation of the suitability of wood for prefabrication in the 1920s. In cooperation with the sawmilling and furniture industries, standard houses were developed to serve the needs of the Swedish population after World War 1 (Niemeier and Dederich, 2009). During this time, huge technical advances were achieved and by 1930, prefabricated wooden catalog houses were offered by more than 20 Scandinavian companies (Smith, 2009).

In the postwar period after World War 2, standard houses were developed in Finland. Construction manuals and standard drawings of a wooden single house were made accessible and buyers could purchase the necessary building material as an assembly set to build their own house. Parallel to that, Norwegian, Swedish and Finnish companies were the main suppliers especially for the raising demands of single family houses in Germany from 1957 onwards. They offered houses based on the catalog principle, which was a novelty for the German market (Rug, 2006). Here, Swedish companies might have been leading the field, since common speech called these kinds of houses "Schwedenhäuser" as well; an expression that still is being used.

Prefabrication developed from load carrying structures to various assembly extensions and in 1980, wooden single family houses had a market share of 85% to 90% in Scandinavia (Smith, 2009). Today, the degree of prefabrication seems to reach its limit. Parti-

tion-wall prefabrication includes almost all interior installations and fittings and particularly in ready-module houses, integrated interior systems can be and often are mainly manufactured off-site, including e.g. completed electrical and plumbing systems or wallpaper hanging, parquet laying and tiling, see as well picture 1. Consequently, working time on-site is being reduced and action limited to the assembling of modules, see pictures 2 and 3.



Picture 1: Prefabricated module for single family house with already installed heating and ventilation system and other interior fittings. Arrival on-site.



Picture 2: Prefabricated modules for single family house are assembled on-site.



Picture 3: Prefabricated dormer window is assembled on-site.

Due to the high degree of prefabrication, ready-module houses are the most cost effective alternative on the market for wooden single family houses. This attribute bears however the risk of being associated with low budget houses and less good quality. Yet, prefabrication was and still is not only being further developed due to its price advantages. In Scandinavia, it is seen as a different and most of all better method to manufacture

wooden houses (Waern, 2008). *A socially accepted technology: prefabricated wooden houses are less expensive. Not cheap!*

Prefabrication is regarded as improving the quality of the final product, since production settings are protected from weather impact and assembling is easier to control. Yet, as the prefabricated module shape sets architectural boundaries and limits interior arrangements, which might limit the individual self-realization of customers, ready-module houses are mainly marked towards young families who have a tight budget but still want to buy a real estate. Higher income segments, on the other hand, potentially revert to wooden houses produced with more flexible, less standardized and thus more expensive prefabrication techniques than ready-modules, like e.g. partition wall elements. There are prefabricated house alternatives for all market segments. Prefabrication prevails, since market, industry and people accepted, supported and developed it. It is culturally rooted for hundreds of years and the markets are accustomed in a way that makes prefabricated houses more affordable (Smith, 2009).

Considering especially the Swedish wood construction and prefabrication processes as globally being at the forefront (Schauerte, 2009b), the question occurs, why these kind of single family houses are not dominating international markets, like e.g. the German one? Niemeier and Dederich (2009) expressed a possible answer to this question in the following terms. Swedish companies and the construction industry in general are no match for e.g. the German demand of perfection in details. In other words: different nationally rooted quality aspects do often not allow for a 1-to-1 application from one market to another. Product characteristics and details like e.g. doorsteps or insulation of inner walls, to name but a few, are accepted by customers in one but not the other country. This was as well one reason for many Scandinavian companies to backtrack their activities from the European continent in the 1990s, regardless their technological advance in manufacturing.

2. Multistory houses

2.1. Regulations, strategies and projects

As in most other countries, national building regulations prohibited the construction of wooden houses with more than two stories in Scandinavia; except Norway, where three stories were allowed. In the mid and late 1990s, however, these regulations changed and were adjusted towards functional requirements (Schauerte, 2010), compare figure 1.

	Up to 1993	1994	1997	1999	2004	2010
Sweden	2	∞	∞	∞	∞	∞
Norway	3	3	∞	∞	∞	∞
Finland	2	2	4 ¹	4 ¹	4 ¹	4 ^{1,2}
Denmark	1-2	1-2	1-2	4	∞	∞

¹: with sprinkler, two stories without sprinkler
²: under investigation

Figure 1: Number of stories allowed with wood as bearing material in Scandinavia (Östman, 2010)

Sweden was the first of the Scandinavian countries to change regulations in 1994, allowing the infinite use of wood in bearing structures, as long as the functional requirements are fulfilled. Nevertheless, practical concerns limited constructions higher than 8 stories. In 1997, Norway introduced regulation changes, requiring that constructions in high rise buildings have to outlast fire. Apart from that, they are relatively similar to the Swedish regulations. The same year, Finland changed their regulations; yet, only four-story wooden residential houses were approved and restrained to have sprinkler installations. An expansion of the Finnish regulations is currently being investigated. Lastly, Denmark followed in 1999 by implementing changes allowing for four-story houses to be built in wood (Östman, 2003; Tykkää et al., 2010) and from 2004 without limitations in stories (Östman, 2010).

These changes in building regulations enhance the competition on the construction markets and are even perceived as indirectly supporting the use of wood in multistory buildings (Visscher and Meijer, 2007). This, however, seems to leave a false impression. In contrast to that perception, it may be asked why and how regulation changes indirectly support a construction material, if no material restrictions are given, i.e. neither steel, concrete or other materials are banned. Instead, the growing usage of wood in construction can rather be ascribed to its suitability or problem solving ability in various aspects, e.g. prefabrication or environmental friendliness. Further, it can be argued that the displacement or ousting of wood in construction finally has been stopped. In opposition to the perceived indirect support for wood, it could be stated that all other construction materials have been supported earlier, since wood was ruled-out from multistory constructions by placing material-related constraints instead of functional requirements in building regulations.

Referring back to an enhanced competition on the construction markets, it has however to be stated that the markets for wooden multistory houses are developing relatively slowly. One explanation for this might be that markets mostly still are equipped for conventional materials like concrete, steel, brick or stone (Schauerte, 2007) and that the industry, including architects, has to learn how to deal with wood in multistory applications. Here, efforts can be seen and activities have been, and are about to be, performed, in order to accentuate and improve the position of wooden multistory houses, even though these activities differ in their magnitude from country to country. Different national initiatives, as well as programs comprising all Scandinavian countries, have been realized, and some are even ongoing, to trigger the usage of wood in multistory constructions. Below, some projects are briefly described. The ones presented are subjectively selected by the author, who is not aiming for completeness.

In Norway, the project "Norwegian Wood" was intending at putting "...Norway and the Stavanger region on the European architectural map, to ensure that the region in 2008 is in the forefront in Europe as regards modern, environmentally-conscious wooden architecture." (Stavanger municipality, 2008) Here, a series of projects have been completed in 2008 with several prominent architects and engineers working with wood having been invited to participate and compete, to make Norwegian Wood an international exhibition for the building industry. Innovation, high architectural quality, good building practice, high environmental ambitions and a further development of the value-chain as well as research & development activities have been included in the code of practice for all realized building projects (Norske arkitekters landsförbund, 2007; Stavanger municipality, 2008).

In Finland, the "Modern Wooden Town" project was launched in 1999 and will at least last until 2010. The major goal of this initiative is to apply wood constructions to create pleasant new housing areas in different parts of Finland that serve as an example for the future. The Modern Wooden Town concept considers as well current aims of Finnish national housing policy where the development of wooden constructions and the compression of town centers with small apartment buildings should achieve cost-effectiveness and a sustainable development. (Karjalainen and Koisu-Kanttila, 2005)

In Sweden, a national strategy for "more wood in construction" was implemented in 2004, striving at further developing industrialized production processes (Serrano, 2008). This strategy had the vision that wood should be a self-evident material alternative in all constructions in Sweden within 10 to 15 years, and at a somewhat later date even in Europe. To reach this, 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, which can lead to decreasing costs and better products.
- Provide new jobs by increasing the extent of further processing wood as a raw material.
- Decrease of construction defects due to increased degree of industrialized prefabrication. This has the advantage that construction elements can be built indoor,

which leads to improved construction conditions for the product and a better working environment for the employees, which will improve quality controls.

- Environmental protection by sustainable construction. Substituting steel and concrete with wood will reduce CO₂ emissions considerably.
- Giving wood the chance to catch up to other construction materials that were treated preferentially, due to the prohibition of wood in certain constructions. (Näringsdepartementet, 2004)

The three above-described national projects or strategies have several similarities, and the probably most notable fact they have in common is that the national governments either were part of the projects or even took the initiative to start them.

In this regard, the project "Nordic Wooden Cities" has to be mentioned as well. This project comprises Denmark, Norway, Sweden, 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 level, information sharing, sharing of "best-practice" experiences in the whole range of the building process, innovation promoting and supporting cooperation between public and private sector are of utmost importance for the Nordic delegates involved in this project. Today, 17 members are engaged in "Nordic Wooden Cities", whilst new members are welcome to join (Nordic Wooden Cities, 2010).

One condition, that cannot be dismissed when looking for strengths that trigger wood in multistory constructions, is the involvement of the public sector in the Scandinavian countries. Clear stated strategies and goals and, even more important, their implementation give a stronger authenticity to governmental statements on, e.g. how CO₂ emissions should or could be diminished. Here, Scandinavian countries might be an example for other European countries. In various discussions with European politicians it is concluded that wood, as a building material, cannot be advocated as such, since this would be a distortion of competition. This argument is rather absurd for several reasons, yet, since the present paper is not focusing on industry-political discussions nor lobbying, only the most obvious reason is stated here. When setting up, or objectively operationalizing, climate goals, a thorough investigation of facts shows that there are materials that are more suitable to apply e.g. in certain construction than others. In the majority of cases, wood is beneficial. When tendering building projects, many municipalities aim at testing whether or not wood might be an alternative construction material for that very project. Yielding to logic and reason it should however probably be the other way around: If no other material can offer more beneficial features, wood should be used. This precludes at the same time an exaggeration of the usage of wood, since other materials definitively can and should be used in case they are more beneficial.

A similar approach is e.g. practiced in the "Välle broar" project by the municipality of Växjö, Sweden¹. In addition to that, project coordinator Hans Andrén emphasizes the importance of a functioning cooperation between the public sector, the industry and academics. All three parts have a common denominator in triggering the use of wood in construction and the understanding, that each part cannot do everything on its own but benefit a lot if working together. In that manner, wood construction can be lifted to a higher level.

2.2. Markets for wooden multistory houses

Concerning markets and the market share of wooden multistory houses, difficulties occur to gather data since national statistical agencies often do not collect information about material use in construction. In Norway, e.g., different statistics have to be combined in order to estimate the share of buildings with more than four housing units build in wood². In 2006 and 2007, the corresponding market share was 56% and 52%. With comparable quantities, the market share decreased by 22% to 30% in 2008. In 2009, a downturn of

¹ Read more about this project in Schauerte (2007).

² I would like to thank sen. reseacher Anders Q. Nyrud, Treteknisk, Oslo, for providing me with the requested information for the Norwegian market.

32% in quantities occurred; however, the market share of wooden multistory houses remained at a level of around 33% (Tret teknisk, 2010).

As mentioned above, the Norwegian statistics comprise buildings with more than four housing units. In addition to that it has to be noted that it was allowed to construct wooden buildings up to three stories even before the 1990s. Thus, a conclusion might lie at hand that the rather high market share of wooden multistory buildings in Norway mainly has to be ascribed to two or three story houses and that only a smaller part of the share attributes to higher buildings. However, that part of the market share is not known down to the present day, the author could at least not be provided with corresponding numbers on request.

In Finland, statistics capture the market share of wooden multistory houses in two different ways. First, according to m^2 build in total and second, according to the number of finished buildings. The market share of wooden multistory houses up to four stories is 2.5% when it comes to m^2 , and 10.6% when calculated in relation to the number of finished houses³. This means that housing units in wooden houses are rather small, compared to housing units in houses with other materials. These numbers include housing units in two-story houses as well.

In Sweden, the market share of wooden multistory houses has been growing since the implementation of the above described strategy for more wood in construction. Reaching about 10% in 2005 (Stehn et al., 2008), it exceeded 15% in the 2009 and is continuing upwards (Svensson, 2009; Schauerte, 2009a). However, in contrast to Norway and Finland, Swedish data only displays buildings with more than three stories. This is due to the fact that it already was allowed to build two-story houses in wood before 1994 and that the difference from then on is of particular interest. According to Jan Lagerström, Swedish Forest Industry Federation, it is currently being worked on developing a statistical database comprising all wooden multistory houses with two or more stories.

Concerning the Danish market, no data could be presented to the author on request. Nevertheless it might be probable and fair to conclude that wood in multistory constructions only plays a minor role in Denmark. The market for single family homes is still on a relatively low level, as described before, and differentiates itself from the other Scandinavian countries. Shortage of raw material on the domestic market might serve as one possible, yet nonetheless unsatisfactory explanation to the author that should be further investigated in the future.

The above shows, that numbers on market share hardly can be compared between the Scandinavian countries, since different national intents determine how „market share“ is being operationalized and thus measured. Consistent data, like e.g. wooden houses with more than two stories and two housing units, would simplify such a comparison.

3. Concluding remarks

All in all it can be said that wooden house construction has a long and well-routed tradition in Scandinavia. The development of industrialized production processes for single-family houses seems to reach its limit while the development for multistory applications has just begun. The latter can hopefully lead to a change on the construction markets towards a higher degree of utilization of wood. One aspect that is of referent power for other European countries is the culturally accepted way of building. Prefabrication is regarded and accepted as a high-qualitative and less expensive production method. Further, the official involvement of governmental instances, like e.g. ministries of the environment or economics, is a beneficial aspect for projects aiming at triggering the usage of wood especially in multistory constructions.

However, industry should not just wait for the public sector to act. A concentration of activities is often required to reach considerable success. Small one-shot projects do not have enough power in itself compared to a series of linked projects. Involved actors

³ “Thank you” to prof. Matti Kairi, Aalto University, and Pekka Pajakkala, vice president at the Technical Research Centre of Finland, VTT, for helping me with the data for the Finnish market.

should merge towards project groups in order to centre their activities and pull into the same direction. What somehow sounds like a cliché and reminds of a managerial textbook image is successfully implemented in the “Välle broar” project in Växjö in Sweden⁴. There, public sector, industry and academics have a common denominator, i.e. lifting wooden construction to the next level. However, each actor would spend too much energy if “fighting for itself”. By concentrating energies towards a common goal, synergy effect emerge which makes the three involved parts to a modern triumvirate of wood construction. This constellation should be applied elsewhere as well!

4. References

Kaden, T. (2010). *Holzbau vertical: neue 5 – 7 geschossige Wohngebäude in der Stadt.* Dena-Dialog regional, 16.09.2010.

http://www.dena.de/fileadmin/user_upload/Download/Veranstaltungen/2010/dena_dialog_berlin/Reimer_web.pdf Version current as of 2010-09-21.

Karjalainen, M. and Koiso-Kanttila, J. (2005). *The Modern Wooden Town Project (1999 – 2010) in Finland.* Conference proceeding of the XXXIII IAHS World Congress on Housing, September 27 – 30, 2005, South Africa, Pretoria.

<http://repository.up.ac.za/upspace/bitstream/2263/10420/1/The%20Modern%20Wooden%20Town%20Project%20in%20Finland.pdf> Version current as of 2010-10-25.

Näringsdepartementet (2004). *Mer trä i byggandet – underlag för en nationell strategi att främja användningar av trä i byggandet,* Ds 2004:1, Regeringskansliet.

Lavoie, P. (2008). Green building trends are advancing wood as a building material. In: Wahl, A. (edit.) (2008). *Wood Market Trends in Europe.* FPInnovations, Special Publication SP-49, ISSN # 1916-4238.

Niemeier, A. and Dederich, L. (2009). Standardisierung am Beispiel Schweden. In Schwaner, K. (edit.) (2009). *Zukunft Holz.* Kap. 6.2 Produktionsverfahren. Hochschule Biberach. ftp://ftp.fh-biberach.de/pub/www/IfH/01_Zukunft_Holz/zh_k06.pdf Version current as of 2010-09-20.

Nordic Wooden Cities (2010). *Nordic Wooden Cities – et nordisk samarbejde,* <http://nordicwoodencities.com/website4/1.0.4.0/5/1/index.php> Version current as of 2010-10-25.

Norske arkitekters landsförbund (2007). *Norwegian Wood,* <http://www.arkitektur.no/?nid=58419> Version current as of 2010-10-25.

Paper and Wood insights (2010). *Puurakentaminen ja puutaloteollisuus,* <http://www.metsateollisuus.fi/infokortit/puurakentaminen/Sivut/default.aspx> Version current as of 2010-09-20.

Rug, W. (2006). *Entwicklung der Holzhausindustrie.* Conference proceeding of the 10. Holzbautagung Berlin und Brandenburg, 24. Nov. 2006.

http://www.holzbau-statik.de/Holzbau/downloads/Holzbauband_2006_Inhalt_Rug.pdf Version current as of 2010-09-20.

Schauerte, T. (2007). Schaufenster in eine bessere Zukunft – Holzbau und mehr für eine ganzheitliche und nachhaltige Stadtentwicklung. In: Hochschule für Architektur, Bau und Holz – HSB (eds.) (2007). 13. Internationales Holzbau-Forum, *Holzbau aus der Praxis – für die Praxis*, No. 2, Biel: Fraunhofer Verlag.

Schauerte, T. (2009a). Wood construction in Sweden from 1994 to 2008. In Hochschule für Architektur, Bau und Holz – HSB (eds.) (2009). 15. Internationales Holzbau-Forum, *Holzbau aus der Praxis – für die Praxis*, No. 2, Biel.

Schauerte, T. (2009b). *Investigating Consumer Perceptions by applying the Extended Association Pattern Technique – A Study on Wooden Multistory Houses.* Acta Wexionensia, No 194/2009. ISSN 1404-4307, ISBN 978-91-7636-683-7.

⁴ Read more about this project in Schauerte (2007).

Schauerte, T. (2010). *Consumer Perceptions on Wooden Multistory Houses: Segmenting International Markets.* Proceedings of the 2010 SWST and UNECE-TC Annual Convention "The Role of Wood Science in the Green Building Movement", Palais des Nations, Geneva, Switzerland, Oct. 11-15, 2010.

Schmidt, L. (2009). *Industrialisering av trehusproduksjonen – en kunnskapsoversikt.* NIBR rapport 2009:18.

Serrano, E. (2008). Inledning och bakgrund, p. 1 – 10 in Serrano, E. (ed.) (2008). *Uppföljnings- och dokumentationsprojektet Limnologen – översikt och delrapporter i sammanfattning.* Växjö universitet, School of Technology and Design, Report No. 47.

Smith, R.E. (2009). *History of Prefabrication: A Cultural Survey.* Proceedings of the Third International Congress on Construction History, Cottbus, May 2009. https://www-docs.tu-cottbus.de/bautechnikgeschichte/public/openaccess/smith_oa.pdf Version current as of 2010-09-20.

Stavanger municipality (2008). *Norwegian Wood,* <http://www.stavanger.kommune.no/SVG2008ENG/index7641.html?event=projects.showProject&id=16&catId=78> Version current as of 2010-10-25.

Stehn, L.; Rask, L.-O.; Nygren, I. and Östman, B. (2008). *Byggandet av flervåningshus i trä – Erfarenheter efter tre års observationer av träbyggandets utveckling,* Luleå tekniska universitetet, teknisk rapport 2008:18.

Svensson, N. (2009). Telephone interview 2009-11-17.

Thelandersson, S., Aasheim, E. and Ranta-Maunus A. (2004). *New timber construction in Nordic countries.* Keynote presentation at the World Conference on Timber Engineering 2004. http://www.ewpa.com/Archive/2004/jun/Paper_069.pdf Version current as of 2010-09-20.

Treteknisk (2010). Based on data from Statistics Norway and Prognosesenteret. E-mail correspondence with Anders Q Nyrud, Treteknisk, Oslo.

Tykää, S., McCluskey, D., Nord, T., Ollonqvist, P., Hugosson, M., Roos, A., Ukrainski, K., Nyrud, A.Q., Bajric, F. (2010). Development of timber framed firms in the construction sector – Is EU policy one source of their innovation? *Forest Policy and Economics*, No. 12, pp. 199-206.

USDA (2006). *Denmark. Solid Wood Products. Annual. 2006.* Global Agriculture Information Network Report No. DA6012. <http://www.fas.usda.gov/gainfiles/200612/146269754.pdf> Version current as of 2010-09-20.

Visscher, H. and Meijer, F. (2007). *Dynamics of building regulations in Europe.* International Conference on Sustainable Urban Areas, ENHR, 25-28 June 2007, Rotterdam, Holland.

Waern, R. (2008). Scandinavia: Prefabrication as a Model of Society. In: Bergdoll & Christensen (edit.) (2008). *Home Delivery,* New York: The Museum of Modern Art, pp. 49-51.

Östman, B. (2003). Ny nordisk handbok för brandsäkra trähus. *Hysbyggaren* 2/2003.

Östman, B. (2010). *Brandtekniskt säkra trälösningar.* Keynote presentation at SPs Byggsdag – modernt trähusbyggande, Borås, 30. September 2010.

Model Scandinavia: modern wooden house of Scandinavian design made of laminated log. Scandinavian design has become a well-known brand around the world. While designing this project we became inspired by the functionality and rationality of Scandinavian design. The project's planning comes from the folk architecture of Scandinavian countries and reflects certain modern tendencies in country house construction. Lack of sunlight and shady winter climate of Northern countries require a lot of natural light. The living room has natural light on two storeys and dining room offers panoramic view