



Potential of European Birch Species for Product Development of Veneer and Plywood

Recovery, Grades and Mechanical Properties
and Future Market Requirements

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Aims of the presentation

- **Review the potential of (further) product development for veneer and plywood products based on European silver birch (*Betula pendula* Roth.) and white birch (*Betula pubescens* Ehrh.).**
- **The approach is a combination of**
 - **selected empirical results on the properties of birch wood materials and value of products - three large projects of the Finnish Forest Research Institute in 2000's**
 - **putting the results in proportion to the perspectives of product segments, selection criteria among customers and log supply - focused discussions with experts from Finnish veneer and plywood industries and complementary knowledge from recent scientific literature.**

- **The empirical results cover here:**
 - 1) volumetric yield, visual grades and commercial value of veneers from experimental rotary cutting from timber stands of both species,**
 - 2) with the reference of logs of planted silver birch from Finland and both species from north-western Russia,**
 - 3) static bending properties and Brinell hardness of wood from logs of silver birch and white at different sites and age classes in Finland.**
- **The evaluation of perspectives gives implications to the competitiveness of industries and future economic insights of the branch in the Baltic Sea Area in Europe**

Production of birch plywood and veneers totalled to **3.4 mill. m³** in the Baltic Sea Area in 2006

Russia 2.4 (approx.)

Finland 0.66

Latvia 0.26

Estonia 0.08

Lithuania 0.02

Birch provided **73 %** of all non-coniferous production in the ten countries of the area. Germany and Poland are here the two dominant producers of other hardwoods (1.1 mill. m³), completed with Sweden and small volumes from Norway and Denmark (total 0.2 mill. m³).



Sources: ForesSTAT & FAO, 2008

Birch plywood mills are large-volume units of forest industry groups, 30,000 to 150,000 m³ per year.

Main end-uses of products:

1. Vehicle industries: floors and walls of trucks, trailers, containers and buses
2. Shipbuilding: furnishing of cruising ships, isolation boxes for liquefied natural gas (LNG) carriers, small-scale marine applications (special)
3. Construction: structural panels, concrete forms, also: indoor acoustic panels, wind turbine blades, aviation applications
4. Aesthetic uses: furniture, flooring (also parquet), wall panels, high-price cupboards and cabinets, misc. decorative uses (also veneers)



Photos Vesa Ala-aho



Photo Tapio Wall

Birch veneer mills are small, specialized units, parts of forest industry groups or independent family enterprises, range of production 3,000-10,000 m³ per year (some mills: 500-1500 m³). Products go solely to appearance applications (facing, specialities).



Birch veneers, rotary cut



Flame birch veneer, rotary cut



Curly birch veneer, rotary cut



Birch resources

- **Two birch species are commercially notable: silver birch is the desired birch species due to its faster growth, larger size in mature stage and better overall quality in terms of stem form and branchiness than white birch**
- **However, the differences in the wood properties are considered such minor that the two species are not separated from each other in any industrial end use.**
- **Silver birch accounts for only 10 % of all birch volume in the forests of Finland, but for 60% of the log resources in the actual log growing area in the southern half of the country**
- **Wood quality in birch logs is now changing when raw materials from plantations (silver birch) and drained peatlands (white birch) are increasingly entering the roundwood market**



Metla/Erkki Oksanen

High-quality silver birch in a plantation, Finland ...



... but the thinning logs are still poorer ...



... than the large-dimensioned final-cutting logs of silver birch



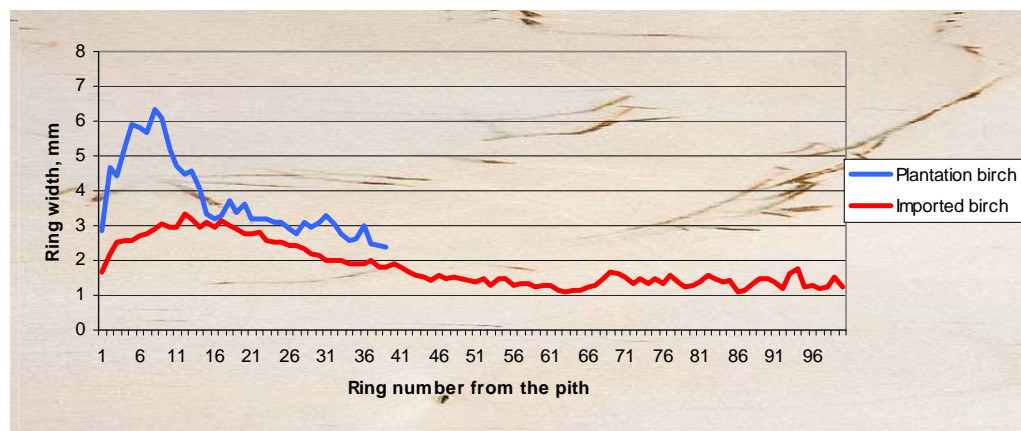
... or normal logs from N.W. Russia – silver and white birch.

Birch species as raw material

- **Currently, resources of birch logs are practically in full use in Finland, Estonia and Latvia, whereas in Russia, in particular, there is a potential for increasing log harvesting.**
- **Simultaneously, the demand of birch wood is intensifying for bioenergy, but eventually decreasing for paper pulp - board pulp seems to keep better.**
- **New value chains alter the demand for and costs of different grades of roundwood and by-products in the birch-using sectors.**

Wood of birch species

- Wood of both birch species is diffuse porous, and relatively uniform as regards to the difference between early wood and latewood – and even sapwood and latewood (and moisture distribution) - and has a moderate shrinkage and swelling.
- Wood of both species is light coloured – silver birch brighter and white birch greyish
- Density, stability and mechanical properties are slightly favourable for silver birch, but general homogeneity and grain texture for white birch

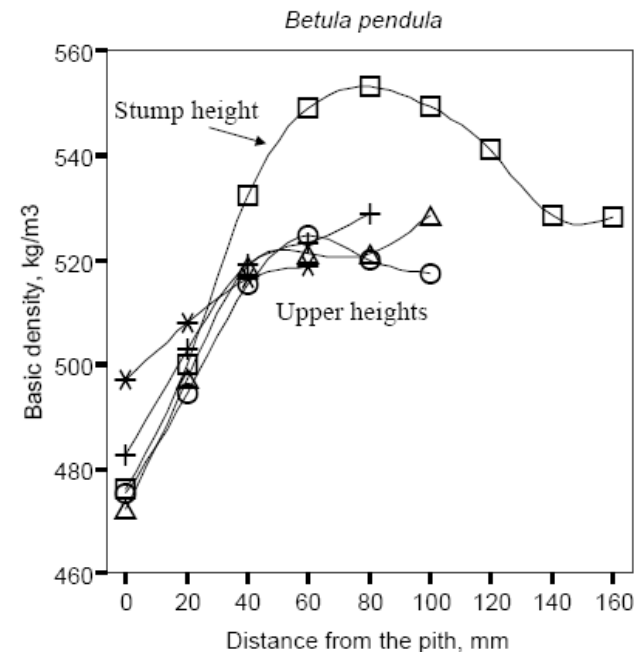


Source: Heräjärvi & Arponen 2008

- Birch has an average basic density of 480–520 kg/m³
- Density variation is much larger radially than vertically. Wood is at its heaviest in the lower parts of the stem and near to the stem surface.
- On mineral soils, density is slightly higher on fertile than poor sites, the effect is opposite on peatlands.
- Between-species differences in density are often curtained in practical plywood and veneer mill operations by the effects of knottiness, grain deviations and tension wood.

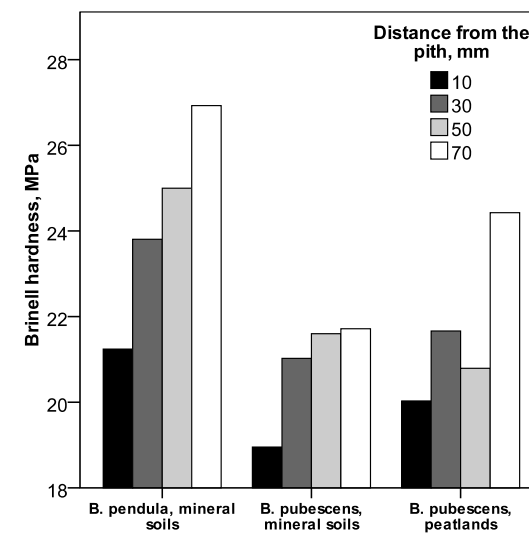
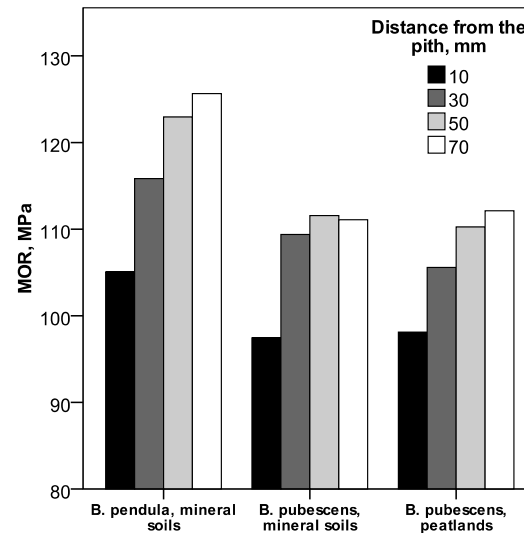
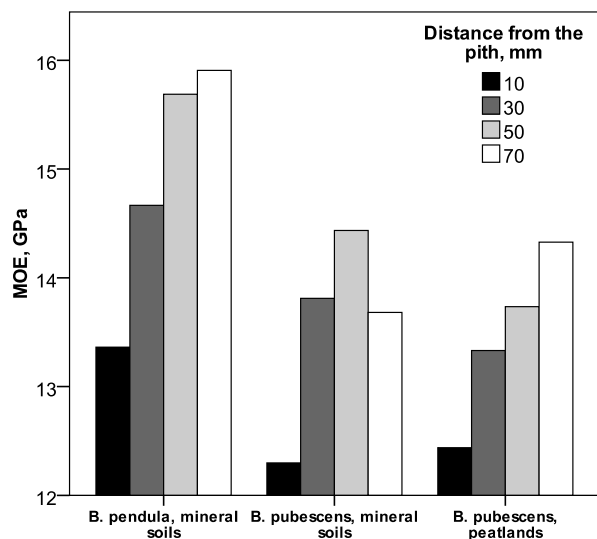
Basic density of birch logs (Heräjärvi 2002)

	Mean, kg/m ³	SD, kg/m ³
<i>B. pendula</i> , mineral upland	511.9	41.5
<i>B. pubescens</i> , mineral upland	478.0	30.8
<i>B. pubescens</i> , peatland	491.9	39.5

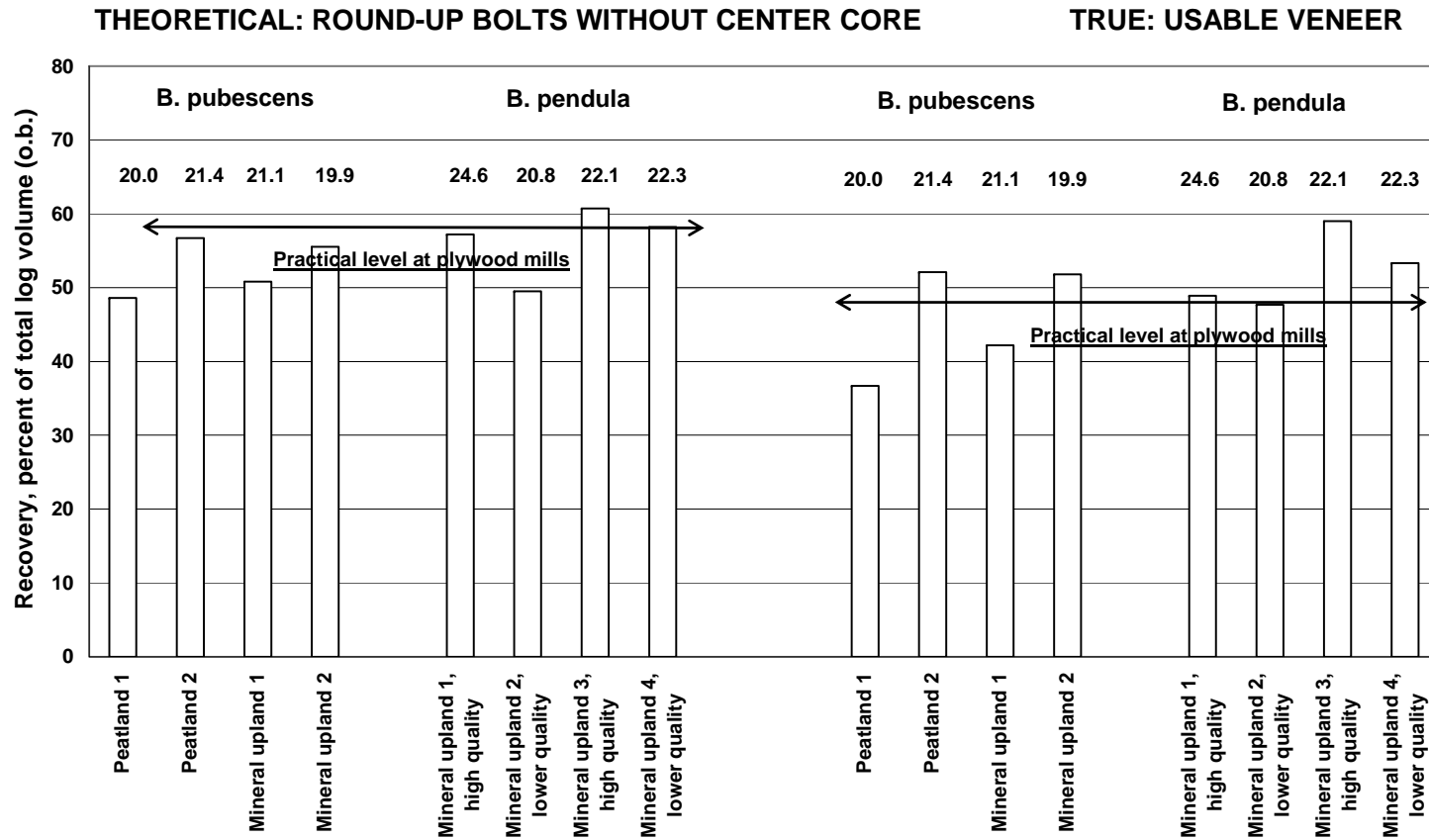


Mechanical properties

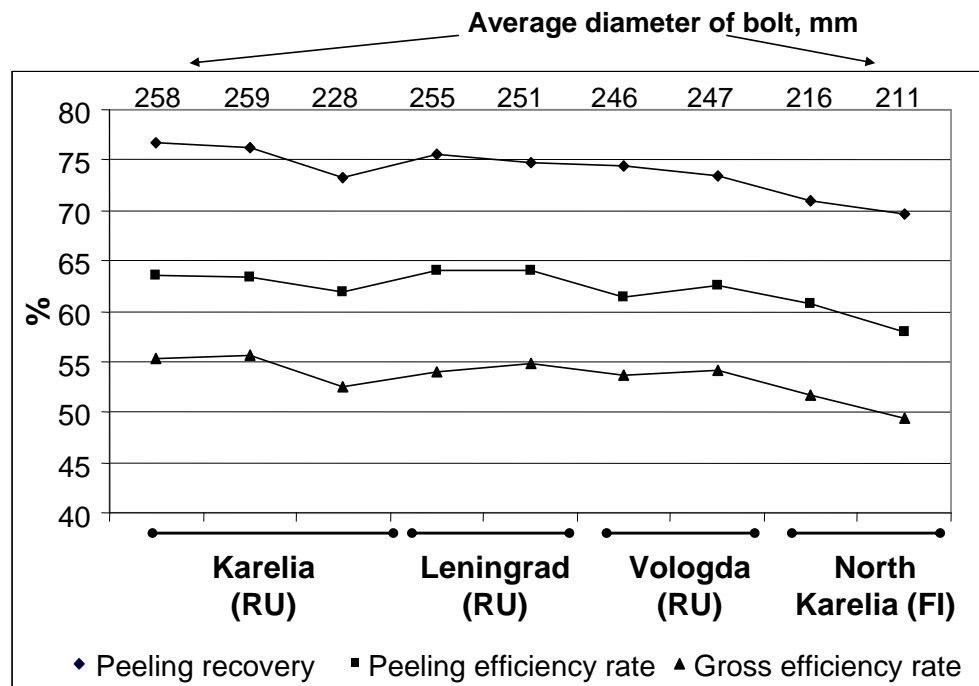
- Within-tree variation according to density.
- Modulus of elasticity, modulus of rupture and Brinell hardness do not significantly differ between the white birch trees grown on mineral soils or peatlands, but silver birch provides a notably better mechanical performance.
- In plywood production, the best strength grades are obviously obtained from surface veneers of silver birch butt logs.



Veneer recovery



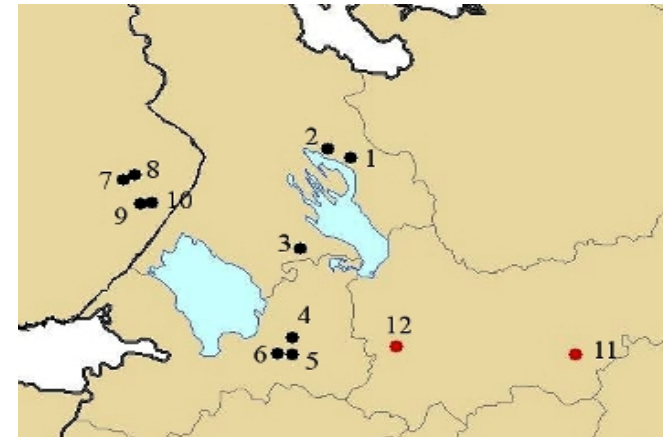
Total recovery of green veneer from experimental logs of white birch (*B. pubescens*) and silver birch (*B. pendula*) from peatlands and mineral uplands. Practical levels at plywood mills are shown as horizontal arrows (Koponen 1995). Mean log diameter is shown for each lot. (Verkasalo 1997).



Peeling recovery: Volumetric proportion of wet veneers of the volume of debarked, trimmed bolt

Peeling efficiency rate: Volumetric proportion of wet veneers of the volume of unbarked log

Gross efficiency rate: Volumetric proportion of dried and trimmed veneers of the volume of unbarked log



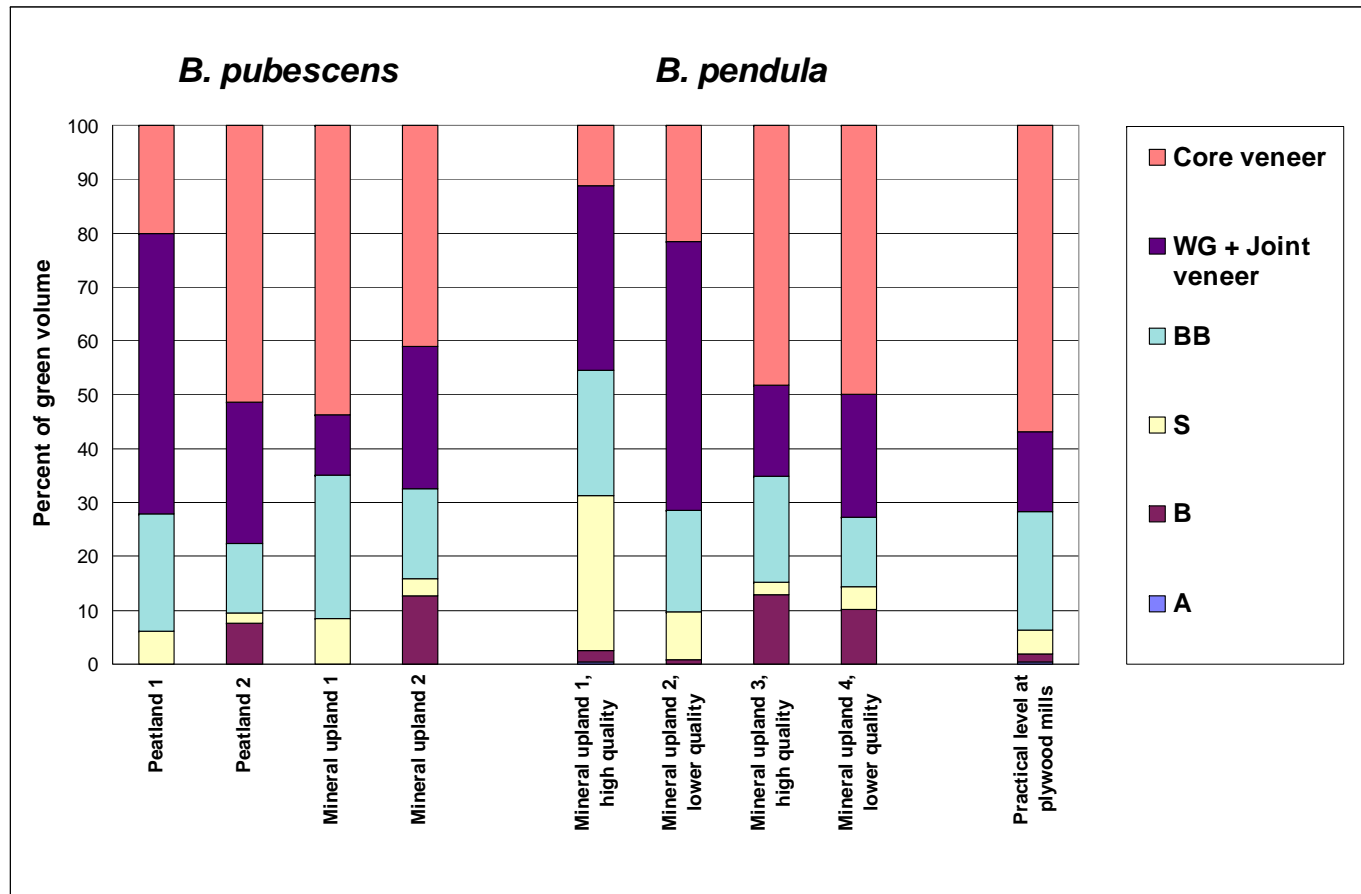
Location of study stands in N.W. Russia and Eastern Finland

Average figures at Finnish plywood mills with up-to-date technology

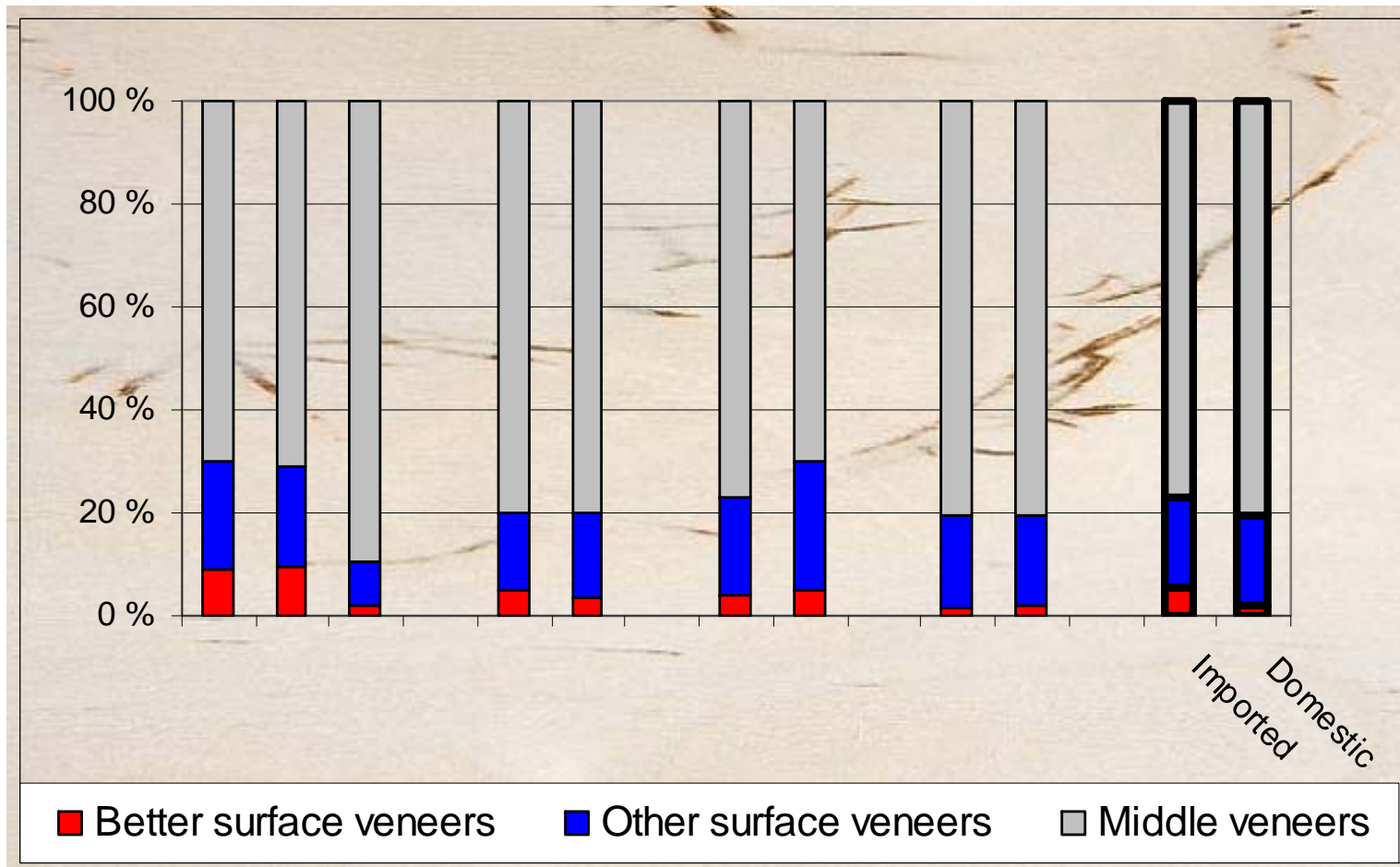
- Peeling recovery 70 %
- Peeling efficiency rate 60 %
- Gross efficiency rate 55 %
- Yield of basic plywood 40-45 %

Results from peeling experiments of birch plywood logs from seven Russian naturally grown final-felling stands and two Finnish planted second-thinning stands (Arponen 2007).

Veneer grade distributions



Grade distributions of green veneer from experimental logs of white birch (Betula pubescens) and silver birch (Betula pendula) from peatlands and mineral uplands (Verkasalo 1997). Average distribution at Finnish plywood mills is shown in the column on the right (Koponen 1995).



Grade distributions of dried veneer in peeling experiments of birch plywood logs from seven north-western Russian stands (final fellings) and two Finnish plantations (second thinnings) (Heräjärvi and Arponen 2008).

Market perspectives

- **Based on different FAO scenarios, global demand of plywood and veneers is growing about 1.7% during the next 10 years (comp.: 0.9 % for sawnwood)**
- **The average global per capita consumption has remained at the same level for 30 years - 0.009 m³ in 2002 (industrialised countries 0.027, Oceania 0.015, Asia 0.007, Latin America 0.005, Eastern Europe (excl. Russia) 0.005, Russia 0.003, and Africa 0.001**
- **The consumption is expected to increase in the developing countries; it already increased since the 1960's much more rapidly in Asia and since the 1990's in Oceania than in the developed countries. The growth rate continuously slowed down in Europe and North America.**
- **It was predicted in early 2000's that in Europe there will be only a moderate GDP and population growth affecting demand and prices of forest products, and the market balance in plywood will be fragile unless increasing per capita consumption levels are achieved in economically developed countries.**

- **After the enlargement of the European Union, the most important factor in the Baltic sea region is the growing production in and export from Russia:**

=> plugged again the roundwood flow of birch around the Baltic Sea at the level of 1990's.

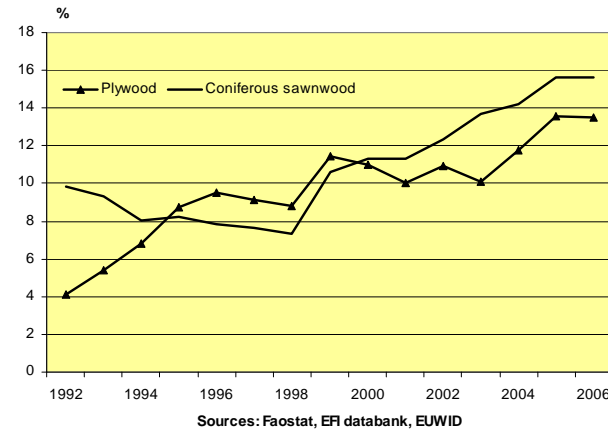
=> impact on the industry competitiveness in different countries as well as the product markets.

- **The production of birch plywood grew rapidly in north-western Russia since the 1990's, and the growth continued at the rate of approximately 10% per annum until the economic recession**

- vast birch resources, growing domestic consumption and, so far, good competitive ability of export to the European markets

- big production growth mostly in the Russian domestic companies; the individual domestic companies are still generally smaller than the few foreign ones from Finland and Germany

- During the 2000's, Russian plywood exports increased by 60%. Simultaneously, the costs of logs and labour have been growing.
- The prerequisites for the further investments in Russia are the true stability and predictability of the political atmosphere, and the stable infrastructure for log harvesting and transportation.



Russian market share expanding in EU25 imports of sawnwood and plywood.

- China with its strong GDP growth and high competitiveness increased and will increase its role in the global plywood markets.
- As global future export opportunities will arise in South-eastern Asia, also competition will be growing there (for example, establishment of fast-growing plantations in China).

Market requirements and product development

- **Birch veneers and plywood have an acknowledged position in certain niche markets, where the specific properties of the before-mentioned birch species can be implemented efficiently and economically, with a superior technical match to the end-use requirements.**
- **For the technical properties and the relationship of price and quality, birch plywood has few competitors and, thus, threats of substitution.**
- **Future's product and customer segmentation and market positioning and the changing raw material basis affect crucially the potential and needs of product and processing development in veneer and plywood industries.**
- **During 2010's, the end-use requirements of birch plywood emphasize the functionalities for consumers, on one hand, and the technically superior properties for industrial customers, on the other hand.**

- **Birch wood as it provides a large potential for visually attractive products for interiors and furniture. The product segment is versatile, but much dependent on the trends of fashion and cultural appreciation of light-coloured appearance.**
- **Decorative plywood is usually faced with hardwood, including birch, red oak, maple, lauan (Philippine mahogany) and a large number of other hardwoods.**
- **Design systems based on plywood, for example, interior wall elements or acoustic indoor rooms, have been introduced, stressing collaboration between manufacturer, designer and customer in the delivery chain.**
- **High-quality finishing to regulate and homogenize colour and texture and to protect surface from wear and UV-light is vital in many customer segments.**

Improvement of surface properties

- Birch plywood and veneer are said to have an excellent surface hardness, damage and wear resistance.
- However, competitiveness in flooring and furniture products requires improvements in surface hardness of birch.
- Finishing oils with an optimized retention have been developed for the purpose, leaning on the good permeability of birch wood - it is possible to raise birch in this respect to the level of oak.
- Here, surface roughness and adhesion properties of birch are also objects in product development.
- Biological incising may be used to improve phenolic resin retention.
- Using certain salt compounds as the effective media the surface hardness may be improved triple fold.
- Impregnation with water-borne agents can be applied to veneers, but not to plywood – or any other wooden material with gluelines.

- **Water glass impregnation with a strong solution of potassium silicates was recently introduced to raise surface hardness of birch by 150 %; simultaneously, the wood becomes stable against moisture-induced defects and fire resistant. Impregnation with furfuryl alcohol compounds is under testing.**
- **Compressing drying may be used to improve surface hardness and stability against cracking, as well – hot pressing works in this way!**
- **A challenge is to develop service-free or self-cleaning birch surfaces using bioactive agents. Selected fungi may be used to slow down the growth of mould and discolorising fungi on wood surface, birch among others.**
- **A challenge is to obtain clear birch material**
 - **even light colour (with no dark stripes, streaks or decay) – avoid insect and fungus damage <-> forest management, moose control, optimisation of wood sourcing, fast logistics from the forest, automated veneer sorting practices and defect control, hot press optimisation and post-press storage**
 - **minimal knottiness <-> diameter development, growth space control, automatisisation of sorting practices**

Improvement of mechanical properties

- Birch plywood is characterised by its excellent strength, stiffness and resistance to creep. It has a high planar shear strength and impact resistance, which make it especially suitable for heavy-duty floor and wall structures. Oriented plywood construction has a high wheel carrying capacity.
- Modulus of elasticity and bending strength are definitely the most important criteria of mechanical performance in construction uses (houses, bridges, concrete formwork systems, supporters of parquet etc.), but also in the structures of different vehicles, such as buses, lorries, containers and ships.
- Good elastic properties are needed also in, for example, wind turbine blades, isolation boxes for liquefied natural gas (LNG) carriers, and in marine and aviation applications.
- Surface hardness is needed as itself in house flooring and furniture, but also in the floors of different vehicles and containers. Sufficient hardness is a prerequisite for proper coating with different films or sheets, as well.

- **Veneer strength may be improved, both for the structural use aspects (bending and tension) and veneer processing (tension perpendicular to grain) provide development potential through**
 - **optimising forest growth conditions and genetic provenances and clones (higher density, minimal knottiness, straight grains)**
 - **technological improvements in log peeling, cutting and handling (no cracking, straight grains), veneer drying (no cracking, accurate control of MC) and veneer sorting (objective automated practices)**
- **Recent industrial tensile strength tests on the veneers showed that the specimens originating from the surface parts of the bolts are weaker than those near the pith or in between the two cases.**
- **Mechanical properties of plywood, especially surface hardness and resistance to wear are heavily dependent on coating – this has been and will be one focus in research and development.**

Process technology and wood sources

- **The processes of rotary-cutting birch are now close to their optima as regards the volumetric recovery, but the value recovery could still be improved.**
- **In veneer slicing, the machinery is varied, and mostly behind the rotary-cutting lines.**
- **The development work focuses now on making veneer sorting more efficient and rising the productivity of manufacturing small lots of plywood.**
- **Its is notable that the size of an individual sale has continuously decreased (e.g., high-quality furniture plywood), but also very large lots have come to the market (e.g., plywood deliveries for LNG carriers).**

- **In Finland, the main part of birch logs for the most demanding uses is obtained from 60-80 year-old, naturally-born silver birch stands and from mixed stands where silver and white birch are growing among Norway spruce and Scots pine.**
- **Thinning operations of silver birch plantations provide only medium quality veneers for the time being; therefore, the logs should be allocated to mills that manufacture coated plywoods.**
- **In the future, we expect high-quality birch veneers from plantation forests as the log dimensions increase and the quality improves for knottiness.**
- **Marginal lots to complete the domestic log flow for large dimensions and, hopefully, high quality may still be available from the neighbouring countries**
- **However, the Russian export tariff of roundwood and increased prices of birch logs are influential now; also, the quality of Russian birch is much more dependent on the local supplier than is the case in Finland.**

Thank you for your attention!

Merci pour votre attention!



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