DOI: 10.1515/aslh-2016-0014 Acta Silv. Lign. Hung., Vol. 12, Nr. 2 (2016) 157–171

The Hungarian Wood-Based Panel Industry and its Impact on the Environment

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Abstract – It is well known that worldwide deforestation has a negative impact on the global environment. Forests play an important role in producing oxygen as well as retaining gases that create the greenhouse effect. Forests primarily absorb carbon dioxide, the major air pollutant released by the industrial activities. Energy production is the major source of environmental contamination. In addition to reducing CO_2 emissions, another issue this industrial sector must tackle is to decrease the use of fossil fuels by substituting them with renewable, environmentally friendly energy sources. One of the answers to these challenges is the utilization of biomass as energy sources. However, biomass-based fuels include short bolts, split round-wood, pulpwood, bark and by-products of sawmilling, which are the raw materials for the wood-based panel industry as well. Wood utilization of the forest products industry has a major impact on the delayed release of carbon dioxide stored in the wood. All over the world, just as in Hungary, the wood–based panel industry mainly uses low quality wood resources and turns them into value added products. The elongation of the life cycle of low quality wood materials decreases CO_2 emissions, thus significantly contributing to environmental protection. Furthermore, it is assumed that raw material demand of the wood-based panel industry could be satisfied by focusing on sustainable forest management and well-planned reforestation. Additionally, special energy-plantations may provide extra wood resources, while waste and other non-usable parts of trees contribute to the effective and economic operation of biomass utilizing power-plants.

This paper summarizes the current situation of the Hungarian wood-based panel industry and discusses the effects of the panel manufacturing processes on the environment. Also, it outlines the possible future of this important segment of the forest products industry.

wood-based panel industry / raw material production / biomass utilization / forests for energy production / short rotation plantations / carbon dioxide emission / forest management

Kivonat – A magyar falemezipar jelenlegi helyzete és környezeti hatásai. A természeti környezet és ezen belül az erdőterületek további rombolása visszafordíthatatlan káros következményekkel jár. Az erdő egyik fontos szerepe az éltető oxigén termelése és az üvegházhatású gázok, különösen a légkörben lévő széndioxid megkötése. A környezeti terhelés egyik legjelentősebb tényezője az energia előállítás. E téren a kibocsátott széndioxid mennyiségének csökkentésén túl jelentős kérdés a fosszilis energiahordozók felhasználásának kiváltása az újratermelhető környezetbarát tüzelőanyagra átállított biomassza erőművekkel. Ezeknek az erőműveknek az egyik meghatározó alapanyagai az ilyen módon hasznosított faanyagok, melybe beletartoznak a falemezipar alapanyagbázisát jelentő sarangolt ipari választékok és erdei aprítékok is, rosszabb esetben az erdőgazdaság által kitermelt bármely ipari célra

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egyébként még hasznosítható faanyag is. A fában megkötött szén-dioxid minél későbbi felszabadításában a fafeldolgozásnak és a fahasználatnak fontos szerepe van. A legsokoldalúbban gyengébb minőségű faanyagot hasznosító iparág a Magyarországon is nagy múltra visszatekintő falemezipar. Az iparág a faipar egyik meghatározó ágazata. A hazai erdőgazdálkodás fenntarthatóságot szem előtt tartó tervszerű fejlesztésével megoldható a falemezipar számára megfelelő minőségű és mennyiségű alapanyag biztosítása, valamint energetikai ültevények telepítésével, a felhasznált faanyag összegyűjtésével, a keletkezett hulladékok és az ipari célra már nem alkalmazható faanyag felhasználásával a biomassza erőművek hatékony és gazdaságos működtetése is.

lemezipar / falemezipari alapanyag-termelés / biomassza hasznosítás / energiaerdők / szén-dioxid kibocsátás / erdőgazdálkodás / falemezipar jövőképe

1 INTRODUCTION

Forests are important habitats that are home to diverse forms of life that are governed by the law of nature and human interference. Over the past several decades societies have recognized that further destruction of the natural environment, including deforestation, has a catastrophic effect on the well-being of human life. Two important roles of forests are oxygen generation and the carbon dioxide retention (Shmulsky et al. 2011). For the latter, wood products manufacturing and utilization are key factors in retaining the stored CO_2 by delaying natural decay and burning (Nieder et al. 2008). Due to the intense harvesting of trees over the last thirty-year period, the Earth's forested areas has decreased by an area the size of Hungary (~ 90.000 km^2) annually (Molnár 2005; Barbu 2011). To stop or reverse this trend, a new philosophy suggested decreasing the volume of harvesting and substituting solid wood with synthetic or man-made materials. This practice resulted in the intensive use of metals, synthetic polymers, reinforced concrete, and other types of construction materials. However, the comparison of energy consumption to produce these construction materials shows unfavourable characteristics. If we take the 580 kWh energy required to produce one metric ton of solid construction wood as unity, then the equivalent energy necessary to produce one ton of brick, cement, plastic, glass, steel and aluminium takes 4, 5, 6, 14, 24, and 126 units, respectively (Molnár – Börcsök 2011). Additionally, if we consider the environmental pollutants emitted by the manufacturing processes of these man-made construction materials, the negative impact on the environment is quite clear. In Hungary the only source of renewable material is the forest. Furthermore, timber production requires less energy and can be utilized without generating harmful wastes. Consequently, it is the interest of any society to manufacture products made of wood and that it should be using these wooden products for as long as it is possible (Hoadley 2000).

An excellent example of wood usage in construction is the lookout tower of Pyramiden summit built in 2013 near Klagenfurt at Worth Lake. The 100 m high superstructure is currently the highest wooden structure in the world. Regional timber sources certified by the PEFC were used to erect the tower (Pyramidenkogel 2013).

In Hungary the consumption of wood products (round-wood equivalent) is about 0.7 m^3 annually per person. This figure corresponds to the overall world average, though it is lagging behind the consumption of 1–1.2 m^3 per year reported by more developed countries (Molnár 2011).

2 HUNGARY'S CARBON DIOXIDE EMISSIONS

According to the report of the European Council issued in April 2, 2013, the 200 Hungarian manufacturing companies participating in the European Union's CO_2 regulations (EU ETS) released 21 million tons of CO_2 into the atmosphere in 2012 *(Figure 1).* This means a more than 6% decrease in CO_2 emissions compared to the year 2011. The average emissions of the 27 EU countries shows 1.4% decrease during the same period. While countries like Great Britain and France had increased emissions, Germany stayed on the same level. Poland and Italy decreased their CO_2 emissions, but by fewer percentage than Hungary did. It should be noted, however, that the decrease in Hungarian emissions is mainly caused by a decrease in industrial production, rather than energy efficiency initiatives in manufacturing processes.

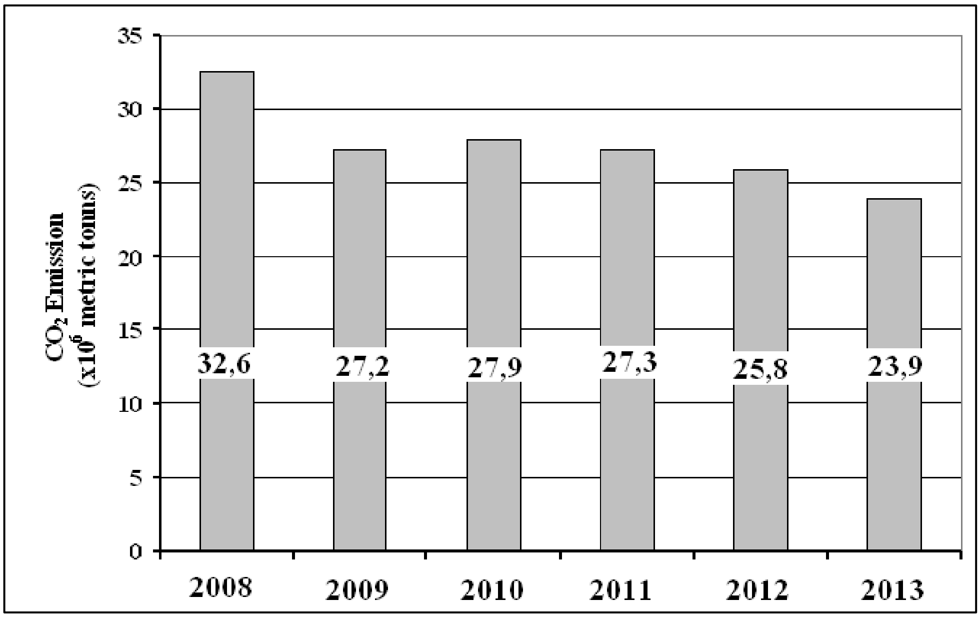

Figure 1. Hungarian industrial carbon dioxide emissions
(Source: KSH STADAT 2015)

According to section 3.3 of the Kyoto Agreement report, since 1990 forest operations (including natural growth, plantations and harvesting) have resulted in 1.26 million tons of net CO_2 absorption. Furthermore, section 3.4 of this report states that other forest management practices resulted in an additional 1.68 million net tons of carbon retention. To adhere to the regulations of the Kyoto Agreement, control of gas emissions that generate the greenhouse effect, is necessary. This can be achieved efficiently by the plantation of new forests (NÉBIH 2012).

3 THE PATHWAY OF WOOD-STORED CARBON DIOXIDE UNTIL RE-EMISSION

Like other plants, trees produce organic materials, absorb water from the soil, capture carbon dioxide from the atmosphere, and release oxygen through photosynthesis. Then, through the transformation of natural sugars, trees build up their different organic compounds. The stored CO_2 in the woody tissues is released during natural decomposition of the material or by incineration (Hinckley et al. 2011). Carbon dioxide emissions are a major cause of the greenhouse effect. Therefore, elongated CO_2 retention is a crucial factor regarding climate change. It is a common interest to keep the stored CO_2 within the woody tissues for as long as possible (Batjes 1999). In this context, the wood-based panel industry has important functions; as represented by the explanatory diagram on *Figure 2.*

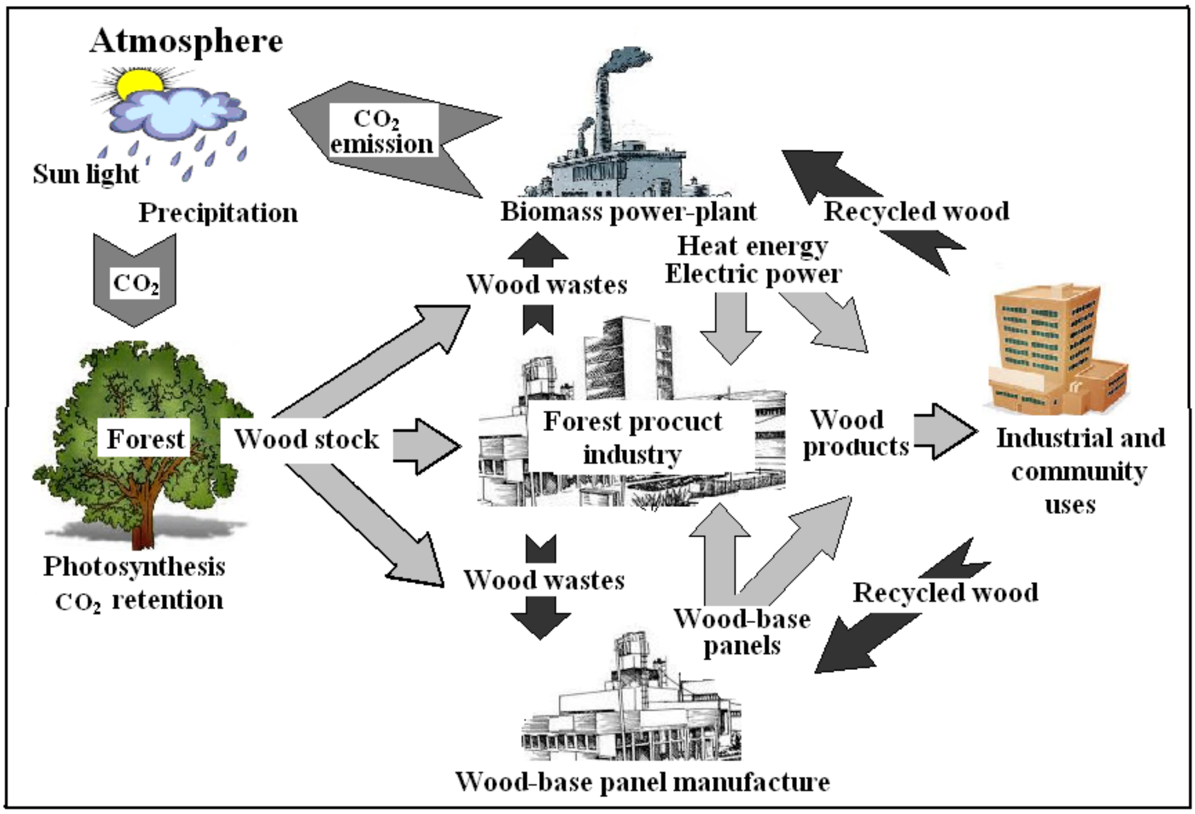

Figure 2. The cycle of carbon dioxide stored in wood. (Source: own construction)

The wood processing industry uses different kinds of solid wood materials harvested from forests. These raw materials contain stored CO_2, and when in the form of different commodities or products, ensure the retention of carbon for a longer period of time.

The other form of utilization of forest resources is energy production. Firewood, forest residuals, and industrial wastes or residuals like bark, wood slabs, etc., are burned to generate heat or electrical energy (Sdrjevic 2007). The forest products industry generally uses its own residues as a supplemental energy source. However, the drawback of this practice is that the stored carbon is immediately released into the atmosphere in the form of CO_2.

The most favourable wood utilization, in view of the carbon cycle, includes the use of wood that is below industrial grade, the incorporation of wastes from other wood processing technologies, and the reuse of former structural wood products (recycled wood) in the wood-based panel manufacturing processes. Thus, the immediate CO_2 emission is eliminated, value-added products are produced in the construction and furniture industries, and long-term carbon storage in wood is ensured.

If we want to emphasize the positive role of wood products in climate protection, then the forest products industry should be run on continuous positive carbon retention. The civilization carbon cycle[1] of wood products is continuously positive if the carbon entering the system is less than the carbon being released or less release than carbon intake occurs (Schöberl 2012). This requires that wood products remain continuously in the civilization carbon cycle for an increased period of time. This may be achieved by the utilization of recycled wood in the wood-based panel industry and decreasing the volume of incinerated wood. However, achieving these goals makes the involvement of judicial and economical regulations necessary.

[1] civilization carbon cycle: the flow of carbon, stored in wood products, caused by human activities

European Parliament and Council renewable energy source utilization directives require that Hungary produce a minimum of 13% of its overall energy consumption from renewable energy sources by the year of 2020 (USZT 2010a).

In addition to CO_2 emissions, another issue is replacing fossil energy carriers with renewable alternatives. Biomass combustion energy plants use environmental friendly fuels that originate mostly from renewable sources (Scurlock et al. 1993). Biomass primarily originating from agriculture and forestry are used to generate heat energy through burning. Other renewable energy sources include biogas, biodiesel fuels, as well as geothermal, solar, wind and hydro energies. In Hungary, 80% of energy currently produced with renewable sources comes from biomass, with about 50% of this volume being wood (USZT 2010b). This amount includes wood resources that may be used for wood-based panel manufacturing, such as short bolts, split round-wood, forest residues, and other types of harvested trees that are still utilized by industry.

Environmental protection is an additional concern that runs parallel with the energy problem. Changing climate conditions require particularly close attention. Hungary volunteered to increase its energy consumption from renewable sources by 14.65% by the year of 2020. This goal can only be achieved if the country produces approximately 3-3.5 million tons of solid biomass annually for the purpose of generating electricity. This biomass volume is equivalent to 7–10% of the country's imported natural gas. According to another study, 10-12 million tons of biomass are needed altogether to achieve the objectives of this energy plan (Lontay 2011). Considering the current yield of fire wood harvesting, the volume of by-products and other waste materials, it is forecasted that at least 100,000 ha new energy-wood plantations would have to be created to satisfy this increased demand. Also, all biomass production should be done by sustainable forest and agricultural operations.

There is great potential to produce biomass on plots released from traditional agricultural cultivations. These areas are possible growing sites for new energy-wood plantations and other types of energy-plants. Biomass production in Hungary shows encouraging features. Within this, based on the traditional forest managements and operations, dendromass production for energy use is particularly feasible.

On the other hand, the extensive establishment of biomass operated energy plants may cause wood shortages that impact the wood processing industry in the region. (De Cock 1999). A typical example of this situation occurred in Austria during the Klagenfurt biomass energy plant project realization where 150 wood processing manufacturers in Carinthia requested guarantees that their wood supply would not be affected by the biomass energy plant that required 300,000 m^3/ of fuel wood per year in order to operate. Prognoses revealed that there would be a round-wood deficiency of about 3 million m^3 in Carinthia by the year of 2020. Between 2003 and 2011, the prices for energy–wood increased by 50% and further increases in fuel wood prices are expected (Klagenfurti Biomassza Erőmű 2013).

Further opportunities in environmental protection for the wood-based panel industry

Wood-based panel production, like all industries using wood, place pressure on a resource that is vital to oxygen creation and environmental protection.

In the quota calculation method introduced in the new section of the Kyoto convention, the quantity of wood-based panel products containing stored carbon of a given year has already been included in the quantity of stored carbon prescribed for the country (Király – Kottek 2013). Therefore, wood-based panel production has become more important in this aspect as the country may obtain considerable additional income from the sale of its unused quotas.

Further environmental protection may be achieved through the marketing of Hungarian wood material and wooden products to familiarize consumers with the beneficial characteristics of wood products; this would also help fortify environmentally friendliness in product choice.

4 THE HUNGARIAN WOOD-BASED PANEL INDUSTRY

The current situation of wood-based panel manufacturers

The economic recession had a serious impact on the Hungarian forest products industry. Since 2005, production volume and net revenue generation show ups and downs, but on average the trend is decreasing. First, the volume of production decreased by 10%; then in 2008, there was a significant increase (22.1%) compared to the production volume before 2005. The largest drop in production (29%) occurred in the following year due to the recession in West Europe. Domestic and export sales dropped by 24 and 40%, respectively. In recent years the demand for export wood products increased by 25.7%, while domestic sales rose only slightly. Since then, production and revenue generation of the forest products industry shows decreasing trends; however, the severity is not so pronounced (FAOSTAT 2005–2015).

Due to changing market and economic circumstances, revenue generation varies year-by-year for important segments of the forest products industry. In 2000, wood-based panel manufacturing was second, with 29.5% share of the total revenue generated by the industry; while construction joinery manufacturing was the first (37%). Based on sales data obtained during the first half of the year 2012, construction joinery product manufacturing preserved its top position, although its overall share decreased (33.4%), while lumber production took the second place (24.6%), and wood–based panel manufacturing dropped to third (23.2%). Despite the drop in the production of important wood products, the import of such commodities is still significant.

Generally, the volume of production is governed by the demand. The decreased raw material need of the largest customers (construction and furniture industries) decreased the demand for wood-based panels. Diagrams in *Figure 3* clearly indicate this trend for a five-year period. The main reason for the drops in production is the closure of manufacturing facilities like the INTERSPAN particleboard plant at Vásárosnamény. The closing of domestic manufacturing facilities triggered some increase in the import of wood base-panels within these weak market circumstances.

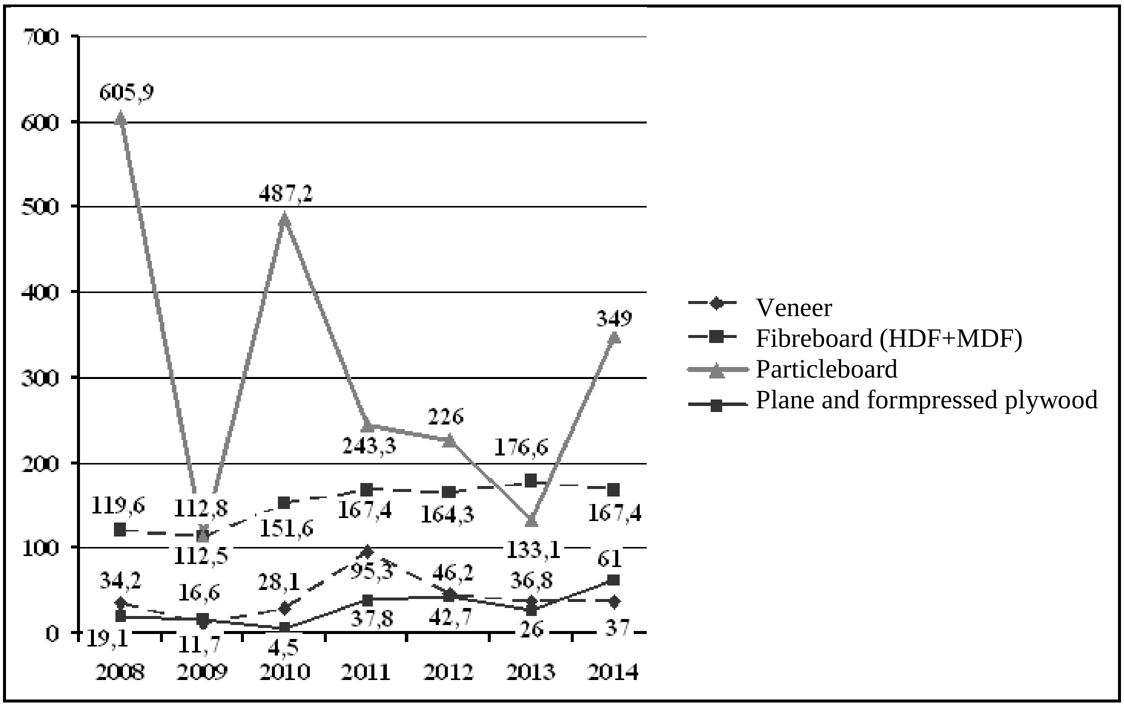

Figure 3. The annual production volume of selected wood-based panel products. Oy: Production volume (x $10^3 m^3$); Ox: Years Surveyed (Source: FAOSTAT data bases 2015)

Despite the decrease in wood-based panel production, production began increasing again in recent years (*Table 1*). For the same period, the foreign trade balance of wood products is compiled in *Table 2*. The substantial negative balance of sawmill products is due to the mill closures that caused increased imports of softwood and hardwood lumber and timber. For the revitalized domestic sawmill industry and for the structural composite manufacturers, this means a possible market area.

Table 1. Production volume of selected wood products (x 10^3 m^3)

Wood Products	2008	2009	2010	2011	2012	2013	2014
Particleboard	605.9	112.8	487.2	243.3	226	133.1	349
Fibreboard (HDF+MDF)	119.6	112.5	151.6	167.4	164.3	176.6	167.4
Veneer	34.2	11.7	28.1	95.3	46.2	36.8	37
Plane and form pressed plywood	19.1	16.6	4.5	37.8	42.7	26	61

(Source: FAOSTAT data bases2015)

Table 2. Foreign trade balance of wood products (x10^3 m^3)

Wood products	2008	2009	2010	2011	2012	2013
Round-wood	537	628	610	832	922	13,012
Sawn wood	–223	–364	–251	–246	–81	–140
Wood-based panels	51	–64	19	4	–149	–148

(Source: FAOSTAT data bases 2015)

The overall European economic recession affected all sectors of the forest products industry and destabilized them financially. Thus, the biggest consumers of panel products, the furniture and construction industries, were also distressed. Furthermore, the raw material producing forest management enterprises were also indirectly negatively motivated.

5 DEVELOPMENT OF MANUFACTURING FACILITIES

Hungary had a great tradition of wood-based panel manufacturing, but through the privatization of state owned enterprises, several smaller plants seized to exist, while the larger facilities were soon acquired by foreign companies. Nevertheless, these mergers did not automatically mean survival. A typical example of such a situation occurred in 2011 when Interspan Kft. in Vásárosnamény was shut down by the Swiss KronoGroup. The owner could not see guarantees for the return of investments totalling about 15-20 billion HUF that was needed to update the entire manufacturing technology (HVG 2010). Instead, a new OSB plant is being built at the same location and it is expected to begin operations in 2016.

For several other Hungarian companies, merging with foreign enterprises meant not only survival, but prosperity as well:

- In 1994 the available wood-based panel manufacturing capacity triggered the formation of Derula Manufacturing and Trade Co. The Italian affiliated manufacturing facility is operating in Szolnok, in Central Hungary (Derula 2013).
- Since 1995, OWI Zala Bt. has been operating as a subsidiary of the German OWI GmbH. & Co. KG. Their products are usually marketed in Europe, but thorough the mother company, they can sell to overseas market as well (OWI ZALA 2013).

- In 2004 the former Fibreboard Manufacturing Co. of Mohacs (MOFA) and KRONOSPAN Holding Limited formed KRONOSPAN-MOFA Hungary Fibreboard Manufacturing Co. (MOFA 2013).
- Szombathely based FALCO particle board plant, established in1939 as a small-scale sawmill operation facility, joined KRONOSPAN Holding in 2007. Since then, it has turned out to be the largest furniture and structural panel manufacturer in Central-East Europe (FALCO 2013/a).

The primary goals of all modern manufacturing facilities are to use high technology and to optimize the price/quality ratio of their products. Beyond these, environmental protection is gaining significance too as customers increasingly prefer products manufactured by environment friendly technologies. There are several establishments like FSC[2], CARB[3], and PFC[4] that evaluate and certify the use of environmentally friendly technologies. The majority of Hungarian wood-based panel manufacturers fulfil the requirements of these environment protective regulations.

Due to constant competition, market success requires significant investment and technological development. Some Hungarian wood-based panel manufacturers won state and European Union grants although these required some self-financing as well. Derula LLC received financial support for doubling its forest area in 2001, and for doubling production capacity in 2013 (HVG 2011; Derula 2013). In 2013, the MOFA-Hungary LLC received financial support to switch from using the wet process to a more environmentally friendly dry fibreboard manufacturing technology. This increased production capacity and by-product utilization (MOFA 2013). A grant received by FALCO Zrt. in 2013 helped them develop innovative surface finishing technologies and contribute to quality and production improvements (FALCO 2013/b). At Furner-Pack LLC, the upgrade of production equipment was financed through a grant (Furner-Pack 2013).

There are two segments of the industry competing for the same wood raw materials, namely the wood-based panel and the bioenergy generating enterprises. Whether or not Hungarian forest management would be able to fulfil increased demand in the long term is questionable.

7 HUNGARIAN FOREST MANAGEMENT

As a consequence of the Trianon peace treaty at the end of World War I, Hungary became the least forested country in Europe with only 11.8% of its territory under forest cover. With significant efforts and investments in plantations, the percentage of forest cover reached 20.8% by 2014. Still, this is only 35% of the European average and compared to the forested areas of Central-European countries like Slovenia (62%) or even Poland (30%), it is a modest value. The long term strategy of Hungarian forest management is to attain 26–27% forest coverage for the country (FAO 2015; Barbu 2011; NÉBIH 2015).

An increase of forest cover yields an increase of current growth and an increase in usable growing stock. However, exploitation is limited to 62.7% of the total forested area designated for industrial utilization. The remaining areas are protected (36.2%) and recreational (1.1%) forests where harvesting for industrial purposes is not allowed (NÉBIH 2014). The volume of tree harvesting is about 70–75% of the current grow *(Figure 4)*.

[2] FSC (Forest Stewardship Council) certifies the use of sustainable forestry operations by monitoring the responsible wood utilization until it reaches the end users.

[3] CARB (California Air Resources Board) certifies the conformance to air quality and contamination regulations.

[4] PEFC (Pan European Forest Certification Scheme) certifies that wood raw material originates from sustainable forestry.

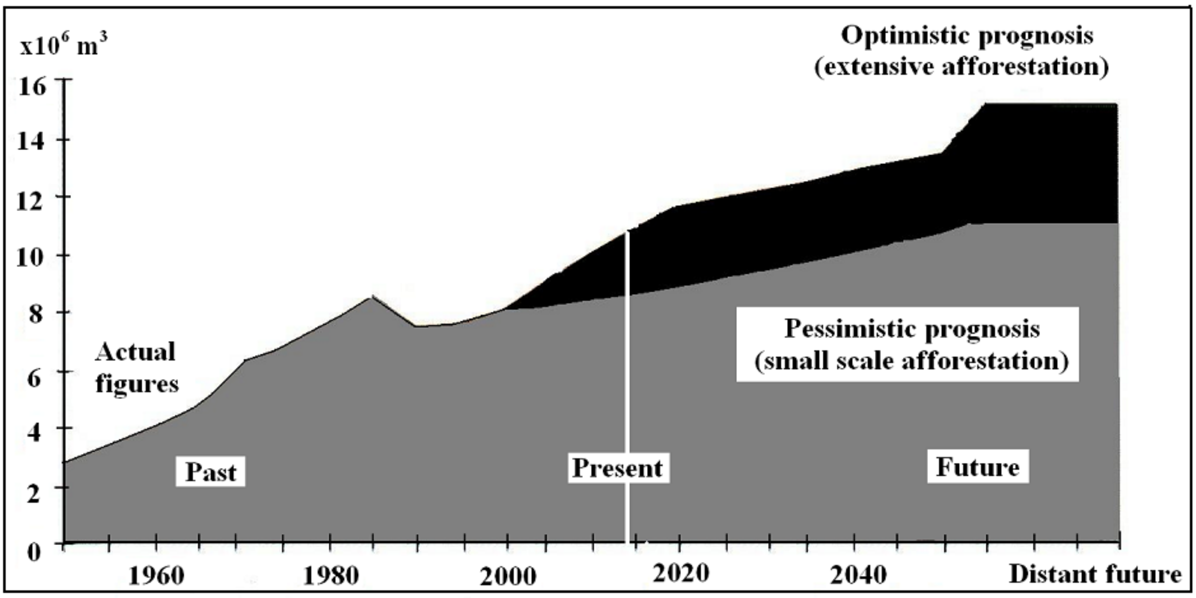

Figure 4. Prognosis of Hungarian timber yield (Source: ÁESZ 2002, p. 62)

Figure 4 shows the actual past, present, and the expected timber yield of the future. The prognosis includes two scenarios. It seems that extensive afforestation will be realized. This means that if the current trend continues, forest enterprises will produce sufficient volumes of wood to supply all domestic sectors of the wood processing industry.

The species composition of Hungarian forests is uniquely diverse (*Figure 5*). Angiosperms are dominant (88.9%) and only 11.1% of the total area are covered with conifers. Native hardwoods like oak, turkey-oak, beech and hornbeam comprise 63% of the forest. The remaining 37% is covered with introduced wood species such as black locust, red-oak, as well as some spruce and pine species. Consequently, this diversity in species determines the composition of split round-wood and fuel wood materials.

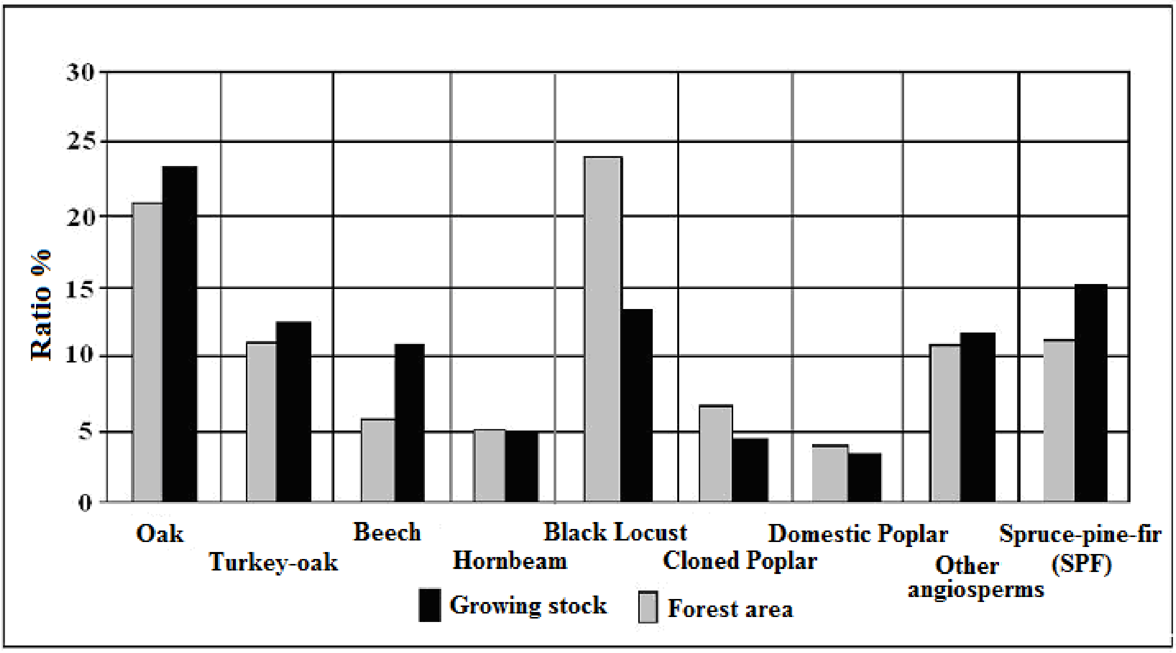

Figure 5. Species distribution of Hungarian forests and growing stock (Source: NÉBIH 2014)

It is worth considering afforestation or plantation forest management on land abandoned by agricultural cultivations because of unfavourable characteristics such as sloping, hard to approach locations, or game-damaged territories. These available areas may be as large as 650-700 kha (Molnár et al. 2008). Plantation trees show improved characteristics within species. For black locust and cloned poplar, the average height increase is about 20%, while in terms of the diameters, a 30% improvement was reported (Németh et al. 2004).

The ratio of domestic and cloned poplar species in the growing stock increased from 7.3% to 10% due to the long term investments of financially stable panel manufacturing companies like Derula LLC in Szolnok. However, the volume of growing stock of beech, which has a longer rotation period, reduced by 0.3% (NÉBIH databases 2010–2014. year). Beech is the most valued raw material of wood-based panel manufacturing. According to a report, the area of good quality beech forest might decrease further (Molnár 2004).

The suitability of two readily available species, the turkey-oak and black locust, for medium density fibreboard (MDF) manufacturing has already been researched. Experimental results indicated appropriateness (Winkler 1999). A poplar-black locust-oak-Scotch pine mixture was successfully tested for particleboard production (Winkler 1998). Unfortunately, none of the above mentioned research results reached commercialization. Wood processing wastes could be a supplementary raw material source of the wood-based panel industry. Wastes or residues generated by different wood processing technologies are usually incinerated to produce heat or electrical energy. Instead of burning wood wastes, the creation of value added products and elongated carbon retention are the key arguments for building these by-products into wood-based panels. All of the segments of the forest products industry generate wastes like sawdust, wood bark, etc. Outcomes of completed research works demonstrated the viability of such wastes for particleboard production. Despite these results, no industrial utilization has happened yet (Winkler 2005a).

Inorganic bonded wood composite panel manufacturing is another major sector of the wood-based panel industry. Several research results demonstrated that wastes produced by other segments of the wood processing industry and domestic hardwoods like black locust and turkey oak can be successfully converted into inorganically bounded panel products. For gypsum bonded fibreboard, the use of recycled flue-gas, gypsum and fibre-silt creates not only a good quality panel, but eliminates environmental hazards as well (Winkler 2005b).

Experiments with fibrous plastic wastes were conducted at the fibreboard manufacturing plant of Mohacs. Results showed that residues of packaging material processes can be transformed into structural panels (Winkler et al. 2005).

The volume of green trees increased continuously during the past years. By now, the growing stock is about 13.1 million gross m^3 annually (NÉBIH 2014). This increase is partially due to sustainable harvesting, afforestation practices, and the conversion of forest structures. Additionally, less demand for woody raw materials resulted in less extraction than allowed by the annual felling target.

The primary purpose of energy-forests is to provide fuel for biomass operated power-plants. However, such special forests may also contribute to the raw material supply for wood-based panel manufacture if appropriate technology is used for the conversions.

The composition of the 2338.3 ha of recently planted energy-forests has three dominant species. Namely, they are willow, black locust and poplar species *(Figure 6).*

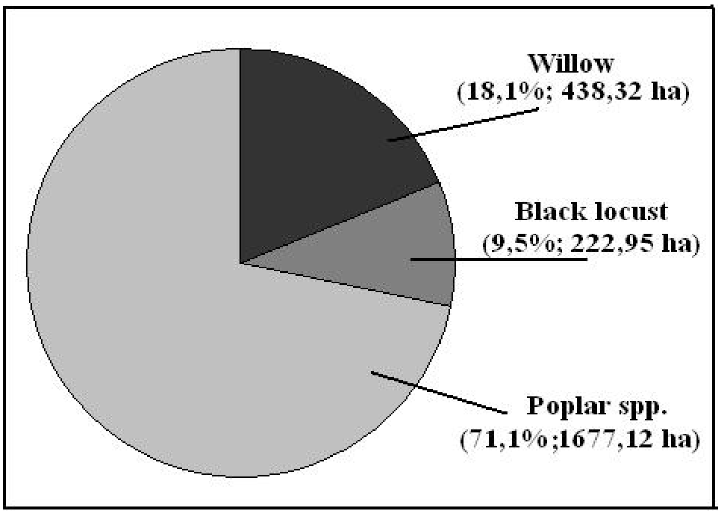

Figure 6. – Species composition of planted Hungarian energy-forests.
(Source: NÉBIH 2013)

Table 3. The use of wood-based biomass in Hungary

Application type	Domestic raw materials	Imported raw materials
Direct use for energy production	3.5 Million m^3 firewood 5,000 tons pellets 2,000 tons wood briquettes	78,000 m^3 firewood 15,000 tons and other archives
Indirect use for energy production (waste)	65,000 m^3 wood waste for energy purposes	240,000 tons wood waste for energy purposes
Short rotation energy plantation	3,398 m^3 (poplar and willow)	–
All energy	656.3 ktoe	89.5 ktoe

(Source: NÉBIH 2014)

The use of wood-based biomass is based not only on domestic available supplies, but also on additional imported sources (*Table 3*). The latter could be reduced or even completely replaced by further afforestation, which could affect major cost savings.

Further possibilities to increase the area of plantation forests are:

- Drained flood-plains and flood-prone areas are excellent growing sites for near-to-nature plantation forests.
- By controlling water supply on former flood-plains, the non-native species may result in plantations having different growing cycles.
- Planting drought resistant (xeromorphic) non-native species on arid growing sites may increase dendromass production.

The major advantage of plantation forests is that fast growing, non-native species can be cultivated. This provides quick return of investments for the owners and lessens the extractions from the primary forests. However, there is a hazard that non-native species become invasive and may transmit dangerous infections to which the indigenous trees are not immune (OEE 2012).

The major financial basis of forest management and forest conservation is the revenue generated by forest sales (Gémesi 2005). Only 60% of the volume allowed by the harvesting plans is realized as gross logging. From this about 1.5–3% are high quality veneer logs that are the raw materials for veneer-based wood panels and decorative veneers (Németh – Szabadhegyi 2003).

Besides wastes/residues of the forest products industry, the raw materials of particleboard, fibreboard, cellulose and paper manufacture are stacked and split round woods. These comprise 20% of the total volume of harvest, while the fuel wood share is 50% (NÉBIH 2010–2015). These two forest materials gained importance because of the widespread use of wood as fuel for energy generation. However, split round wood use for wood–based panel manufacturing generates significantly higher revenue than can be achieved by burning (Fekete 2004).

The volume of industrial use saw logs is about 15–18% of the total harvest. The highest quality saw logs are usually exported though. The price and utilization of the domestically available stock may be affected by foreign polices of forest management. This indirectly harms the local wood–based panel industry. For instance, in Poland the profitability of the forest products industry and workplaces are endangered because German entrepreneurs buy out Polish forest lands near the border. They pay a higher price than the local market value because in Germany the exploitation of forests had been limited (Barabás 2013). It is expected that in Romania the significant volume of log and timber products export will be limited to protect the raw material supply of the local forest products industry (Balogh 2013; Barbu 2013). These phenomena can manifest in Hungary too and may influence the wood supply and the current situation of the wood processing industry.

8 FUTURE OF THE WOOD-BASED PANEL INDUSTRY

Reviewing the raw material supply, as well as the technological and ownership situations of the wood-based panel industry, several trends may be recognized. The interactions between these deterministic factors can influence the future of this segment of the forest products industry. Some facts regarding the existing or expected circumstances may be as follows:

- The quantity of available wood raw material is continuously increasing due to sustainable forest operations. By the expansion of plantations and private forests, a significant volume of good quality industrial wood may ensure the raw material supply of the panel industry.
- The major manufacturing facilities were acquired by foreign companies. The locally produced raw material decreases transportation cost, increases profitability and may motivate the owners to further invest in technology development for which EU and state grants may be available.
- Belonging to large foreign enterprises has a definite advantage. Domestic products can reach an extensive foreign market via the mother company.
- The wood-based panel industry already operates in an environmentally conscious manner. The significance of this segment of the forest products industry may increase in the future. However, its raw material demand is certainly competing with the needs of biomass utilizing power-plants. Plantation of short rotation trees on private and energy forests is one of the solutions for this problem.
- There is a great potential to supplement the raw material source by recycling wood, though it requires a well-developed collection, storage, and redistribution network.
- Finally, the export of wood resources may harm the supply of the domestic wood-based panel manufacturers, thus it should be limited to a certain extent.

9 SUMMARY

Nowadays environmental protection plays as important a role in industrial activities as profitability does. The irreversible destruction of the natural environment, including deforestations, have a catastrophic effect on nature and on the well-being of human life. The forests and the comprising wood species produce oxygen, the basis of life, and absorb CO_2 gas, which is a major contributor to the greenhouse effect. The most harmful load on the environment is generated by energy production. In an effort to decrease CO_2 emissions, non-renewable energy sources the majority of these power plants use, like coal, crude oil and natural gas, need to be replaced by renewable, environmentally friendly fuel. The energy sources of biomass power-plants come from forest operations and agricultural production. It includes short bolts, split round-wood, pulpwood, bark and by-products of sawmilling. These materials are raw materials for the wood-based panel industry. The delayed release of CO_2 in woody materials requires the long-term use of wood products containing stored carbon. Traditionally, the wood-based panel industry of Hungary is one of the most effective segments of the forest products industry in the utilization of low quality wood resources. Its products, manufactured in an environmentally conscious manner, satisfy the international regulations of clean production processes and quality. The raw material demand of the wood-based panel industry could be satisfied with the current afforestation practice in the country. New special energy-plantations not only provide extra wood resources, but the wastes and other non-usable parts of trees contribute to the profitable operation of biomass utilizing power-plants.

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