What Science Can Tell Us

Future of the European Forest-Based Sector:

Structural Changes Towards Bioeconomy

Lauri Hetemäki (editor)

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Contributing authors

Frederike Ettwein, University of Natural Resources and Life Sciences, Vienna, Austria

Lauri Hetemäki, European Forest Institute & University of Eastern Finland

Hans Fredrik Hoen, Norwegian University of Life Sciences

Elias Hurmekoski, European Forest Institute

Riitta Hänninen, Finnish Forest Research Institute

Yves Lesgourgues, Atlantic European Regional Office of the European Forest Institute –EFIATLANTIC

Inazio Martinez, Mediterranean Regional Office of the European Forest Institute – EFIMED

Antti Mutanen, Finnish Forest Research Institute

Annukka Näyhä, University of Eastern Finland

Päivi Pelli, University of Eastern Finland

Peter Schwarzbauer, University of Natural Resources and Life Sciences, Vienna, Austria

Tobias Stern, Wood K plus, Austria

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1.

Introduction

Lauri Hetemäki

The purpose of this report is to provide an outlook of the European forest-based sector for the next 10–20 years. This time horizon is clearly longer than a typical business cycle, but short enough for many current and emerging trends to have a significant influence. The focus is also on forest-based products and the services related to these products. The study is based mainly on published research, although in some places new data and analyses have been used. The emphasis is on the synthesis of existing studies carried out in the European Forest Institute, its member organizations and other research organizations.

Why do we think such a study is important and what is the rationale for its focus? Imagine that in 1980 you were asked to provide an outlook for the European forest sector up to 2000. If you had said that it would look very much the same as in 1980, your response would have been reasonably accurate. Of course, there were some significant changes, but for the most part the European forest sector in 2000 looked rather similar to that in 1980. It was producing very much the same forest products and, as always in the past, more than in previous decades.

If you were confronted with the same question today, and asked to provide an outlook up to 2035, the situation would be very different. This is because the forest-based sector is in a period of many profound structural changes, for which reason the past decades seem to be in many respects a rather poor basis for the future outlook. A number of things have already changed fundamentally in global and European forest products markets with more significant structural changes anticipated over the next 10–20 years. On the one hand, some products are confronted by mature and declining markets in many countries in Europe, and at the same time they are facing increasing competition from the emerging economies. On the other, products that did not exist in the 20th century are already in production today, not to mention the possibilities in the coming decades. The global forest sector is also becoming more complex, interlinked and cross-sectorial. It is increasingly affected by climate change impacts, energy policies, and advances in new technologies, the increasing role of services, and societal and political interests towards low carbon bioeconomies, among others. Many of these changes have linkages and feedback effects, and their impacts depend increasingly on the developments of related economic sectors such as energy and chemicals. Already, the concepts of the 'forest-based sector' and the 'forest-based bioeconomy' are beginning to replace the conventional concept of the 'forest sector'. Moreover, with this development, the challenges between different industries and service sectors related to the use of wood and forests, and potential trade-offs between environmental values and material use are heightened.

This situation is very interesting, promising and challenging for the forest sector stakeholders. This is also true for researchers studying the outlook of the sector. The old models, methods and data are not necessarily very helpful in describing structural changes and the future – not only do they need to be updated, new models and methods must be introduced. Indeed, the recent and extensively cited global and European forest sector outlook studies already appear outdated in some important respects, or they do not address some major issues that the sector seems to be facing in the coming decades. To some extent, the models used by researchers have not been able to keep up with the changes in operating environment.

The purpose of this study is to provide a synthesis of existing studies and provide new insights of the major trends and their implications in the future. We cannot answer all the questions that the future confronts us with. In the end, the future is not known. But hopefully we can ask some new relevant questions, and provide an interim assessment and fresh insights to the future.

We focus on the outlook of the current forest products (pulp and paper, wood products), new forest products (already in production or on the horizon), bioenergy, forest services (mainly related to forest products), and regional implications in central, northern, and southern Europe. We conclude by providing strategy and policy implications for the European forest-based sector. Yet, the situation is such that science does not often have the answers for decision makers. Nevertheless, it may be useful in asking questions no one else is asking, and providing insights no one else is providing.

We acknowledge that this report leaves out many important topics related to the future of the European forest-based sector that deserve their own outlook studies such as climate change, biodiversity, many of the forest ecosystem services and forest conservation. Neither is the focus very much on forest resources (supply), but rather on market usage (demand). In doing so, we hope to contribute to an important knowledge gap that is worth pointing out and drawing more attention to. This is done briefly below.

There are no official statistics that would show the production value of European forest products. However, according to some assumptions and estimations based on FAO and Eurostat statistics, *the value of forest products* produced in Europe was USD 262 billion (EUR 200 billion) in 2012. For the EU27, these figures were USD 211 billion (EUR 160 billion). However, in its documents the European Commission has estimated the European *forest sector turnover* to be even EUR 644 billion.[1] In comparison, for example, the total EU budget in 2012 was EUR 147 billion, and the sum of the revenues of the three European company giants: Nestlé, PSA Peugeot Citroen and Deutsche Telekom in 2012 was equal to value of forest products, i.e., EUR 200 billion. According to Eurostat, direct employment in the EU28 forest sector (wood products + pulp and paper + forestry and loggings) was 2.2 million in 2013, and roundwood production 425 million cubic meters (in 2012). Thus, in terms of income generation, employment and utilization of forests, the sector has significant impact in Europe. Wood is still the main source of financial revenue and employment generated by forests in Europe.

1 The forest products included here are pulp and paper products, wood products, roundwood production and wood fuel. It does not include printing and publishing and furniture industries, which e.g. the European Commission (EC) lists under *forest based industries (FBI)*. According to the EC, *the annual turnover* of the EU FBI is almost EUR 400 billion. The EC Staff Document related to Bioeconomy estimates the forest sector's turnover, including also forestry (not only industries), to be as high as EUR 644.

Nonetheless, given the above figures and the importance of the sector, and specially the future opportunities for forest-based bioeconomy, it is surprising how little academic research there is that addresses the markets and future of the sector. In some respects, the forest products markets fall into a *no-man's-land* in research. It is not the traditional fare of the global or European forest research community, which is to a great extent focused on forest resources. This is also true for this publication series as well as academic journals. Neither are the European economics or business schools and research institutes producing studies on forest-based sector markets to any significant degree. The number of active academic researchers focusing on forest products markets could be less than we have countries in Europe, i.e. 50, and even fewer of those who are actively engaged in providing work on the outlook for forest products markets. Thus, we are currently in a situation where the sector, with significant importance as shown above, is going through its biggest changes perhaps for a century, yet there is very little research on its future. This is worrying!

At this point, for clarification purposes, it is necessary to define the term *'bioeconomy'*. Bioeconomy has in recent years been increasingly used, with many countries publishing bioeconomy strategies, as has the EU. The EU defines bioeconomy as 'encompassing the sustainable production of renewable resources from land, fisheries and aquaculture environments and their conversion into food, feed, fiber bio-based products and bioenergy as well as the related public goods. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries'. The national and EU bioeconomy strategies emphasize the role of new, innovative biomass-based products in transforming societies to low-carbon economies while increasing new income and employment opportunities. The 'sister concepts' for bioeconomy are also often used – 'bio-based economy' and 'green economy'. Bioeconomy is often understood as a sector, whereas the bio-based economy may refer to a transformation of the economy as a whole.

The green economy concept not only emphasizes the role of biomass in moving to low carbon society, but also other renewable energy forms (e.g., hydro, solar, wind), as well as the need for resource efficiency in nurturing environmental and social well-being. According to the European Environmental Agency, '(the) green economy can be understood as one in which environmental, economic and social policies and innovations enable society to use resources efficiently – enhancing human well-being in an inclusive manner, while maintaining the natural systems that sustain us'. That is, it does not only emphasize the opportunities that new bio-based products can provide, but also the need for resource efficiency and enhanced ecosystem resilience. The resilience factor stresses the status, trends and limits of natural systems. The green economy concept is more extensive than bioeconomy, which can also be part of the green economy.

In this report, we focus on issues that are closer to the above bioeconomy definition, rather than the green economy concept. However, this should not be interpreted as implying the superiority of one over the other concepts, but rather how the subject focus of the report is defined. The green economy concept is important, and the resource efficiency and ecosystem resilience objectives are necessary conditions for the future development of societies. Indeed, behind this report is the thought that for the bioeconomy to succeed, it is necessary for it to also embrace the objectives of the green economy concept, as defined above. In addition, we would like to strongly emphasize the inclusion of *services* to the bioeconomy concept, although this is not always evident, e.g., in the EU or in many national bioeconomy strategy definitions. This report seeks

to highlight why it is increasingly important to include services into bioeconomy strategies and policies.

The European Commission has estimated that the *European bioeconomy* has an annual turnover of about EUR 2 trillion and employs 22 million people – approximately 9% of the total EU workforce. Of the total turnover, the forest sector's share is estimated to be 31%, and 22% of the employment. These are clearly rough approximations, and thus should be interpreted cautiously. Indeed, it is very difficult to precisely define what bioeconomy is, and what the forest sector part of it is. Nevertheless, the figures indicate the potential magnitude and show that the forest sector accounts for a significant share of the bioeconomy already today. However, more important than these figures is the fact that by new innovative products and services, and with increasing resource-efficiency, the forest-based sector can contribute significantly more to the wellbeing of Europe. This it can do by generating new products valued by people, income and employment, while at the same time helping to solve environmental challenges.

This report also aims to generate a synthesis and new policy- and stakeholder-relevant insights into the future of the European forest-based sector. By doing this, it also aims to contribute to overcoming the deficit of such studies. The report is organized as follows. First, it analyses the development and outlook of the major traditional forest products, i.e., pulp, paper and wood products. This is followed by a chapter synthesizing the long term outlook assessments for forest-based bioenergy demand and the potential forest biomass supply for this purpose. An analysis of and the outlook for new forest products is then undertaken. This is purely a qualitative analysis since there is a lack of data or a strong basis on which to provide quantitative assessments of the future developments. The following chapter, also related to forest products, discusses an issue that has not been addressed by forest sector outlook studies to date. It focuses on services mainly related to forest products' value chains and their expected increasing role in terms of competitive advantage, value creation and employment in the European forest-based sector in the future. The report then analyzes the somewhat different characteristics, developments and outlook of the forest-based sector in three major regions of Europe: central, northern and southern Europe. The report ends by crystallizing and synthesizing the overall development of the European forest-based sector based on the report's analysis. It concludes by outlining key messages, insights and policy implications.

2.

Forest products market outlook

Lauri Hetemäki and Elias Hurmekoski

Structural changes

The global forest products markets have undergone a drastic change in the 21st century. The emerging economies (e.g. China, Brazil, Indonesia and Russia) are increasing their relative importance while the European Union and North America are declining – their share of global *forest products production* in 21st century, for example, has significantly been reduced, while at the same time that of Asia has increased markedly (see Figure 1 a, b). Moreover, the absolute levels of production in the EU and North America have also been in decline in recent years. The big question is to what extent this is due to economic slump since 2008, and to what extent due to *structural factors* that will impact the markets also after the business cycle turns to a boom.

The structural changes in the European forest industry are also reflected in statistics. For example, in the Confederation of European Paper Industry (CEPI) countries, representing about 90% of European paper and paperboard production, many key statistics showed declines by about one-third from 2000 to 2013 for employment, added value of production and the number of companies and paper machines, among others. Investments also declined even by 46%. The changes in the EU28's wood products industry have been similar to the paper industry, although not as big, and probably more due to economic slump rather than structural reasons. Figure 2 gives the employment trend in the EU28's forest and manufacturing industries. Employment in the paper industry has been declining since 2000; in the wood products industry, there was a slight decline during 2000–2007, after which the decline has been dramatic. What is also clear is that employment in the forest industry in the EU28 is declining more than the manufacturing sector.

The above statistics and trends give a rather bleak picture of the European forest sector. However, it would be premature to use these to paint the full picture of the future of the forest-based sector. First, the aggregate figures mask the different developments of the sub-sectors. For example, engineered wood products and some packaging paper sectors are performing well despite the slow economic growth in recent years. Even more importantly, many global- and European-level drives are creating demand and technological opportunities for new forest-based products and services, as shown in this report. However, before analyzing the latter, a more detailed outlook for the current forest products is presented. As different forest products follow distinct patterns, we will examine pulp and paper, and wood products separately.

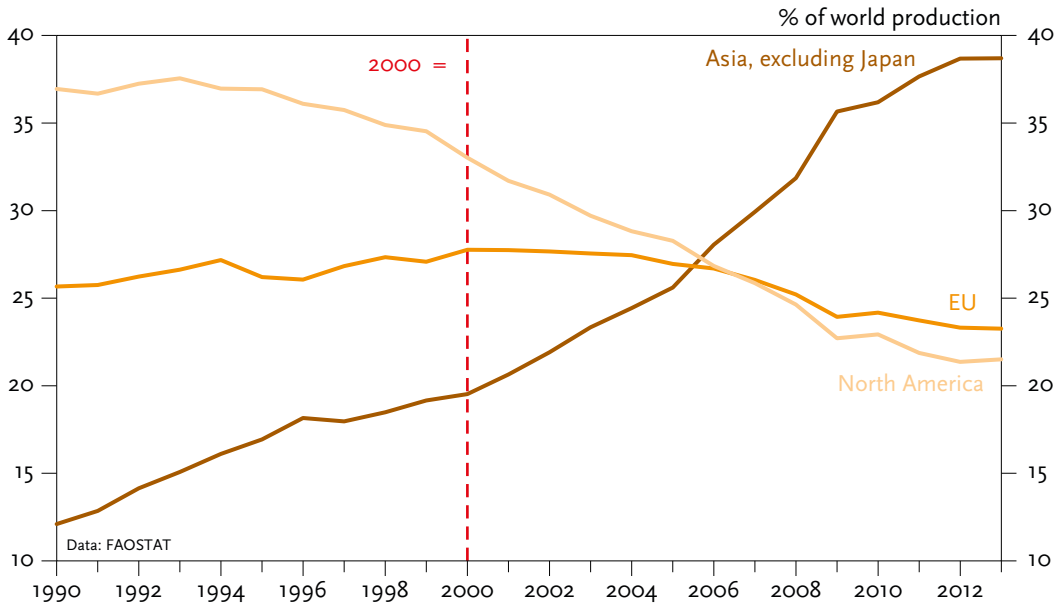

Figure 1a. Market shares of world's paper and paperboard production, 1990–2013 .

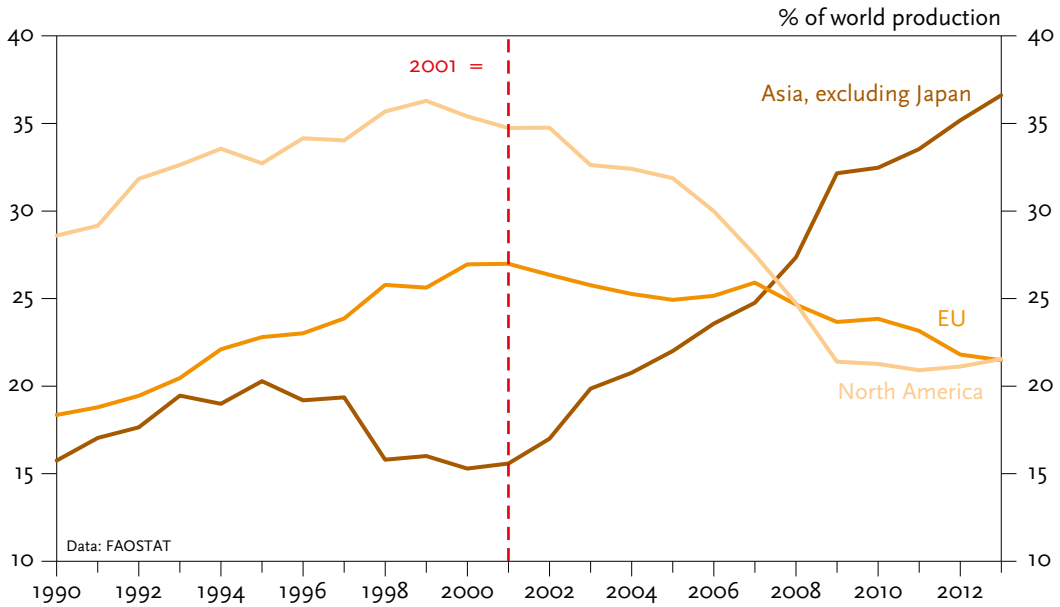

Figure 1b. Market shares of the world's sawn wood and wood panels production, 1990–2013.

Pulp and paper markets

The pulp and paper industry is highly diversified in terms of products, raw materials, product qualities, distribution channels and end-uses. For instance, tissue, cartonboard and newsprint have very little in common apart from their basic production processes and being capital intensive. Pulp, paper and packaging boards are typically intermediate products, used as inputs in the production of other value-added products while

Figure 2. Employment trend in the paper and wood products industries and the manufacturing sector in the EU28, 2000–2013.

other products, such as tissue and office papers, are generally distributed to consumers without further conversion.

In terms of the *value of production*, paper is clearly the most important forest product category in Europe. In 2012, the total amount of paper and paperboard products produced in Europe was 105 million tonnes at an estimated value of USD 100 billion (using the 2012 average export unit value as a basis of valuation). This is slightly higher than the aggregated value of sawnwood (USD 33 billion), wood panels (USD 33 billion) and pulp (USD 31 billion). In terms of the amount produced or consumed, packaging and board products accounted for 52% of the total paper and paperboard production in 2012; the share of printing and writing paper and newsprint together (graphics papers) was 45%. However, in terms of export value, graphics papers are somewhat more important in Europe than paperboard and packaging papers.

At the global level, aggregate paper and paperboard production has continued to grow during this century. If this growth trend continues in the current decade, global production would increase by 83 million tonnes during 2010–2020, i.e., almost the same amount as the EU's production was in 2012 (93 million tonnes). However, it appears that the pace of this growth may not continue in the future. The average global paper production growth rate has been declining: in the 1980s it was 4.4%; in the 1990s 3.4%; and 2% in 2005–2012. Clearly, this significant change in the growth rate has many implications.

The major reason behind declining overall global growth appears to be driven by saturated or declining consumption of some major paper products in high-income OECD countries. If global paper and paperboard markets were divided into two regions, *high-income regions* (North-America, Western-Europe, Japan, Australia and New Zealand) and *low-income regions* (the rest), the differences in consumption patterns become more striking.

An interesting observation is that in 2000, paper and paperboard consumption in the high-income region was twice that of low-income countries; however, aggregate

consumption was higher in the low-income region already in 2010. Consumption has become saturated and even declined in high-income countries. If consumption trends of the last decade were to continue in the coming decade, consumption in the high-income region would decline by 2020 to the level it was in the late 1980s, while in the low-income countries, consumption would be over 50% higher than it was in 2010.

One of the major factors influencing growth in low-income countries has been the extraordinary development in China. During 2000–2010, Chinese paper and paperboard consumption grew by 143%. However, this was outstripped by a 182% increase in Chinese production. These changes have had significant impacts on the global paper and wood fibre markets.

For many experts, these changes in the global and EU pulp and paper markets have come as a surprise. For example, the extensively cited recent projections made by, for example, the European forest sector outlook study (EFSOS II / UNECE-FAO) in 2011, the EUwood study in 2010 and some global and North American outlook studies, project increasing consumption and production of paper products to 2030 or even 2060. In essence, the past trends are more or less projected to continue, and no structural changes are expected.

On the other hand, some experts and studies have been projecting structural changes and stagnating or declining graphics paper (printing and writing papers and newsprint) markets due to digital media already since the late 1990s. Also, the production growth of packaging and paperboard has been stagnating in the USA and Western Europe this century due to the economic downturn and structural factors. The latter relates to the development of consumer and industrial goods manufacturing, which are increasingly moving to emerging economies such as China. As production has moved there, so has packaging the goods.

Table 1 summarizes at the aggregate level the paper and paperboard markets in different regions during 2000–2012 and projects the development up to 2030. The projection is based on the assumption that the future would follow, on average, the development of 2000–2102. While this is a simple assumption that is unlikely to be realized as such, it is a helpful baseline. As shown in this report, an outlook based on this would be rather different than has been widely projected in recent years. How the future pulp and paper production develops, will also have important implications on forest sector incomes, employment, industrial roundwood consumption and the bioenergy markets. This chapter reviews and analyses in more detail the recent outlook studies for global and European pulp and paper markets, the impact of different scenarios and the issues needing further analysis.

Digital media and graphics papers

One of the most significant features of global graphics paper markets during the past decade have been the significant rise of low-income emerging economies as consumers and producers of paper products, and the simultaneous decline of many of the high-income OECD regions. As a result, a shift from the West to the East has taken place in the global forest products markets. In 2000, for example, the consumption of graphics papers was 2.5 times as high in high-income region compared to the low-income region, while levels are almost equal now; the latter countries are projected to have a higher consumption level in 2014.

In many emerging economies, rapid economic growth, along with increasing urbanisation and educational levels, are generating increasing demand also for graphics papers.

Table 1. Paper and paperboard consumption, production and net imports, and trend projections to 2020 and 2030 (million tonnes).

		2000	2012	2020	2030
Western Europe	Consumption	81	72	71	65
	Production	89	87	90	89
	Net Imports	-8	-15	-21	-24
Eastern Europe	Consumption	13	25	35	45
	Production	13	20	25	31
	Net Imports	0	5	10	14
Asia	Consumption	109	177	234	303
	Production	96	175	236	309
	Net Imports	13	2	-2	-6
North America	Consumption	101	78	63	42
	Production	107	85	73	55
	Net Imports	-6	-7	-10	-13
Latin America	Consumption	19	28	35	43
	Production	15	21	26	31
	Net Imports	4	7	9	12
Africa	Consumption	5	9	11	15
	Production	3	4	5	6
	Net Imports	2	5	6	9
TOTAL	Consumption	320	389	449	514
	Production	322	393	455	522
	Net Imports	-2	-4	-6	-8

Projections are based on using the trend from 2000–2012 (Data: RISI).

For example, in China, India, Indonesia, Poland, Russia and Turkey, all populous countries, graphics paper consumption grew between 60–100% from 2000–2010, depending on the country (FAOSTAT). On the basis of long-term economic growth projections, and the population projections by United Nations, we would expect this trend to continue, at least in the coming decade. However, there is a clear possibility that graphics paper consumption could start to stagnate and decline also in these countries perhaps already by 2020. There are already indications of this in China for newsprint consumption.

However, in case of the *high-income region*, it is much more difficult to use economic growth as a primary driver for graphics paper consumption. For North America and western Europe, for example, it would be imprudent to project graphics paper consumption to grow as GDP grows, except during short-run business cycles.

Clearly, there are many reasons behind the structural changes in graphics paper markets, the most significant being digital media replacing the use of graphics papers. Also, the business cycle has had a negative impact on the graphics paper markets during the global economic recession (after 2008). It has been argued that the business cycle is accelerating the structural change due to digital media. However, it is very difficult to quantify the impact of structural factors vs. the business cycle impacts on global or regional graphics paper markets – both are important. It appears that market development in the USA is an anticipatory example of what is expected to happen to other regions. According to the RISI projection in 2013 for North America, for example, graphics paper consumption would decline from 28.3 million tonnes in 2012 to 17.6 million tonnes in 2028, i.e. by 40%.

The impacts of digital media on print media and the paper industry are universal. Electronic communication supersedes print media in New York, Moscow, Peking or Nairobi in exactly the same way. In emerging economies, however, due to rapid economic growth and urbanisation, there is still a clear *net increase* in graphics paper consumption. Cultural factors and institutions may also play a role. Because of this, there are large differences in the timing and magnitude of the impacts between countries and paper grades. For example, there are differences even in the two biggest western European graphics paper markets, Germany and the United Kingdom. The stagnation or decline has been more moderate in Germany than in UK.

If high-income region consumption follows the trend of 2000–2012 into the next decade, consumption would *decline* by 46% in 2020 from its maximum level in 2000. In contrast, in the same period it would *increase* by 128% in the low-income region. The *world net increase* would be 3% from 2000.

One significant unknown is when and to what extent digital media will start to cause decline in print media consumption in the low-income region? In 2010, the low-income region population weighted average Internet penetration rate was still only 17%, which is what it was in U.S. in 1997. But in some major low-income countries change is taking place rapidly, as in China. According to Internet World Stats, in China there were 621 million Internet users in December 2013, which is the largest number for any country. However, the Internet penetration rate is still only about 46%, whereas it was 84% in the USA. However, the Internet penetration in China is growing very rapidly: if the trend of last five years continues, China's penetration rate will reach the same level as the USA (today's level) in 2018.

In summary, given the rapid spread of the Internet and electronic media, also in the low-income countries, the current rapid consumption growth could weaken already in the coming decade. There are indications that this happening even today. For example, the Chinese newsprint consumption growth rate has already started to decline: in 1995–2004, consumption grew on average by 15.9% per annum; during 2005–2012, however, this figure was only 3.3% and has been steadily declining since 2009.

While the impacts of digital media on the graphics paper sector has very much focused on paper consumption, they are also likely to impact *prices*. Paper companies are not anymore only competing against other paper companies, but increasingly against digital media companies that can provide alternative platforms for information dissemination and publishing. In the face of this increasing competition between print and digital media, publishers of print products are seeking to cut costs, including the price of paper. This makes it harder to transmit the increasing paper production costs to end prices. As a result of this, the paper industry has adapted strategies to adjust for this pressure. First, the industry can continue its cost-cutting strategy by increasing production efficiency. To this end, they may modernize the production processes e.g. by robotizing and using more information technology. Companies can also reduce capacity (close mills and paper machines) in order to maintain the supply-demand balance, and maintain/gain pricing power in the markets they serve. This is what companies have been doing in recent years in North America and western Europe, an essential tactic to keep their current businesses profitable. In connection to this, companies are merging to increase market shares and gain market and pricing power. Finally, the paper industry can develop new products, for which there will also be growing markets in the high-income industrialised countries (see Chapter 4).

Packaging sector increases paperboard consumption

In contrast to the graphics paper sector, digital media is not expected to have a negative effect on *paperboard and packaging paper* consumption. For example, rapidly growing online trading increases the need for packaging, which translates to growth in paper products used for packaging. In this section, we focus on the current state and outlook of the global paperboard and packaging markets.

One of the most important driving forces in determining the success of paperboard is how well it can compete against other packaging materials. Currently, packaging paper and paperboard are the most important packaging materials in terms of market share (35% in recent years) with plastics the second largest. As these two product groups dominate global packaging, their relative competitiveness determines to a significant degree how the paperboard sector will develop in the future.

The global consumption growth of packaging paper and paperboard has been stable during the last two decades with an average annual growth rate of 3.3%. Although packaging markets are affected by global economic changes, economic recessions have generally had smaller negative impacts on paperboard markets than on graphics papers markets. The global growth of paperboard production is mainly correlated to the rapid consumption growth of containerboard, which is used for bulk packaging of industrial commodities. The World Packaging Organization (WPO) expects that growth opportunities exist for packaging in such areas as fresh food and ready-to-eat meals, especially in emerging markets in developing countries. Additional opportunities exist for suppliers in beer and mineral water consumption in eastern Europe, the Middle East and Asia, in particular. Healthcare and cosmetics are also fast growing end-use areas for cartonboard. Despite the significant growth possibilities for cartonboard, plastic packaging is a challenging competitor; according to the WPO, for example, rigid plastics have been, and will be in the future, the fastest growing packaging material.

The rapid increase in the production of paperboard in the low-cost emerging countries (e.g. China) in the past decade seems to have changed the paperboard world price pattern. In the 1990s, there was significant cyclical variation in paperboard prices, but no clear declining trend. During the last decade, however, when rapid production enlargements started in new Asian low-cost countries, a clear declining price trend is evident. This changing world price pattern has been a particular challenge for the profitability of the North American and western European producers.

International trade of paperboard in terms of export and import volumes doubled during 1992–2010 as a result of a number of important changes that occurred in the regional net trade (exports – imports), of which the most important is the volume growth of western European net exports. Western Europe and North America will continue to be important exporters of paperboard in the future due to the stagnating consumption in these regions.

As already mentioned, globalization has rapidly changed the structure of the global forest product markets during this century. Paperboard consumption per capita has started to decrease in North America and to stagnate or even decline in western Europe. One major reason behind this pattern is the fact that consumer and industrial goods production has moved increasingly from North America and western Europe to emerging economies, particularly China. As a result, the goods are being packaged where they are manufactured and thus the packing paper consumption (and production) has also shifted accordingly.

In the other areas where consumption per capita is clearly lower than in North America and western Europe, paperboard consumption is showing steady growth with eastern Europe the fastest growing area. Even small changes in consumption per capita will have a very large effect on the total absolute volume of consumption. Using the trend from 2000–2012 to project future paperboard consumption, it would almost double in eastern Europe from 2012–2030, but there would be little change in western Europe. However, western European production would increase about 12% from 2012–2030. In North America paperboard consumption would be about 23% and production about 10% lower in 2030 than in 2012.

In summary, industrial production and export packaging will continue to grow in Asia with a concurrent relatively lower consumption of paperboard for packaging in traditionally large producer regions in North America and western Europe. An important source of uncertainty in global paperboard markets is China's rapid economic growth rate and concurrent packaging consumption. This is an issue which is very difficult to project. Another important source of uncertainty and potential opportunity relates to the development of new packaging materials and the ability to innovate new packaging products in reaction to the changing needs and habits of consumers. Substitution from alternative materials, particularly plastic, will influence the development of new, wood-based packaging materials. An example of an emerging product/market is intelligent packaging, which combines wood fibres with modern digital information technology, such as interactive pharmaceutical packages that remind people to take their pills with a programmed frequency. Another example is incorporating new technology in packaging that would provide information about food spoilage, which could prevent huge volumes of food waste in the chain of food retailers, wholesalers or consumers.

Food packaging materials and tissue papers are typically the most profitable to produce near their end use and final customers because of high unit transportation costs. For example, cartonboard production for food packaging is typically based on coniferous virgin fibre that is available in the traditional producer countries of North America and western Europe. On the other hand, as tissue products are relatively expensive to transport, they tend to be produced near the consuming markets. Consequently, although paperboard products are currently decreasing in western Europe and North America, the growth of food packaging and tissue papers probably offset this decline to some extent.

Finally, environmental concerns are likely to be an important determinant of the packaging sector's development in the future. This is likely to be positive for the paperboard sector, which uses renewable raw materials relative to the main competing fossil-based plastic products.

Outlook to 2030

There has been very little research on the pulp and paper markets' long-term outlook in recent years. Most outlook studies are published by consulting companies, which also tend to follow market developments more systematically and in more detail. Here, we summarise the most well-known recent outlook studies for Europe by forest economists and consulting companies, and compare them to our own assessments. The studies analysed are the extensively cited EFSOS II study from 2011 and Buongiorno et al. study from 2012, as well as the RISI consulting company studies from 2013. Tables 2, 3 and 4 summarise the main quantitative results of the projections at the European level.

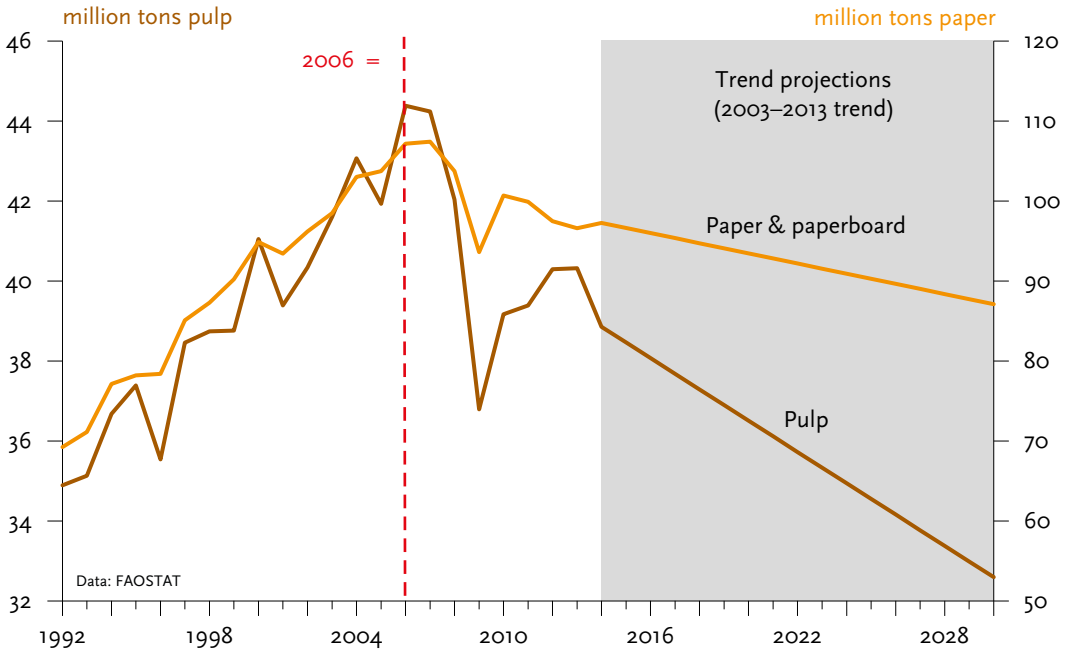

Figure 3. Paper & paperboard and pulp production in Europe 1992–2013 and projections to 2030 (excluding Russia).

The EFSOS II background studies provide data for pulp consumption and production projections to 2030 while Buongiorno et al. provide four different scenarios (Tables 2 and 4 show the scale of these scenarios). The trend forecast in Table 2 was based on data from 2003–2013. The last 10 years may approximate the future trend in the coming decade perhaps better than including earlier years, since they better reflect the recent structural break in the markets. Nevertheless, this trend projection should be interpreted only as one possible scenario, against which other assumptions can be tested. Here, it serves to illustrate an alternative scenario for recent widely cited outlook studies, and to provide an outlook that reflects the development over the past 10 years rather than the last decades of the 20th century.

The '*forecast model*' in Table 4 is based on using paper and paperboard production as an explanatory variable for pulp production. It tracks and explains the changes in the past pulp production (we tested this also by computing out-of-sample forecasts). However, this does not necessarily mean that it will be as good in explaining future pulp production since it may be increasingly used in the future in the textile industry (dissolving pulp), other biomaterials and energy purposes as well as for paper.

The most striking result is that the data from 21st century as well as the projections of this and the RISI studies indicate a rather different outlook than the EFSOS II and Buongiorno et al. studies. More importantly, according to the former studies, the market structures and trends from the 20th century will not continue in this century as EFSOS II and Buongiorno et al. may have considerably overestimated European paper consumption and production up to 2030. The projections from this study indicate that European paper and paperboard production could decline from the 2010 level of 106 million tonnes to 87 million tonnes by 2030 (-19 million tonnes). In contrast, EFSOS II and Buongiorno et al. project an increase of 25–45 million tonnes.

In line with the above projections, the pulp consumption and production projections for 2030 also differ significantly. According to this study, European pulp consumption and production would be in 2030 about 20–30 million tonnes less than the projections EFSOS II or Buongiorno et al. This would, in turn, imply approximately over 100 million cubic meters less pulpwood demand.

The projections of this study are of course only one possibility, and are unlikely to be realized as such. However, they main message they communicate is that the forest sector should seriously assess the possibility of a very different scenario than EFSOS II and Buongiorno et al. suggest since the markets may decline or stagnate instead of growing.

Implications of paper markets on the wood fibre demand

Using the 2003–2013 trend to project EU wood-based pulp consumption, and calculating the associated pulpwood consumption required by using a wood consumption multiplier, we get the projections as shown in Table 4. According to these results, wood pulp consumption in the EU would decline from about 47 million tonnes in 2007 (historical maximum value) to 30 million tonnes in 2030. Correspondingly (using the multiplier), the demand for pulpwood would decline from 142 million m^3 to 90 million m^3. In contrast, the EUwood study projects this to increase to 200 million m^3. That is, if the markets would behave in the coming 15 years as they have on average in the past eight, pulpwood consumption would be *110 million m^3 lower* in 2030 compared to what the EUwood study medium scenario projects.

The lower paper consumption and production would have many impacts for the EU wood balance. First, the demand for paper, pulp and pulpwood will be significantly lower than what has been previously projected. By reducing the demand for pulpwood, it also tends to lower its price (ceteris paribus). However, declining pulpwood demand would also reduce forest residues generation as well as black liquor and tall oil production in pulp mills, both of which could be used for bioenergy production. Since pulp mills are significant producers of bioenergy in many EU countries, it could make it harder to reach the renewable energy targets.

However, it should be noted that in the future, pulp production does not necessarily decline exactly in line with the decline in fine paper production. First, the EU countries can export more softwood pulp (but probably not hardwood pulp due to competition from South America and Asia). Second, some of the old 'paper pulp' plants can be transformed to produce biomaterials and bioenergy, as is already taking place in Finland and Sweden where some plants are producing dissolving pulp for the textile industry. However, when the demand for mechanical papers (newsprint, SC-paper, magazine paper) declines so will the demand for mechanical pulp. Mechanical pulp mills are very unlikely to be transformed to purposes other than producing pulp for mechanical papers.

Industry renewal and transition period

The analysis demonstrates the need to re-assess the pulp and paper industry's long-term outlook in Europe. Some recent widely-cited outlook studies fail to take into account the structural changes taking place in the pulp and paper markets. Due to these, it would make sense to also prepare for the possibility of declining or stagnating paper

Table 2. European paper and paperboard consumption and production in 2013 and projections to 2030 (excl. Russia).

million tonnes	Actual 2013	EFSOS II (2011) 2030	Buongiorno et al. (2012) 2030	Trend Forecast[2] 2003–2013 trend 2030
Consumption	85	125–149	107–118	75
Production	97	128–155	131–151	87

Table 3. RISI (2013a) projections for European graphics paper consumption and production in 2010 and projections to 2028.

million tonnes	Actual Europe 2010	Western Europe 2030	Rest of Europe 2030[1]	Total Europe 2028	Europe 2028 vs. 2010
Consumption	37.8	17	10.8	27.8	-10.0
Production	46.6	24.3	10.4	34.7	-11.9

Table 4. European pulp consumption and production in 2010 and projections to 2030 (excluding Russia).

million tonnes	Actual 2013	EFSOS II (2011) 2030[1]	Buongiorno et al. (2012) 2030[1]	Trend Forecast[2] 2003–2013 trend 2030	Forecast Model[2] 2030
Consumption	45	53–65	55–67	34	
Production	40	47–56	53–64	32	35

1. EFSOS II and Buongiorno et al. provide different scenarios, and the Table provides the range of these.
2. Projections computed by the present study.

production, at least in western Europe, and its implications for the forest-based sector (including bioenergy).

In general, many of the pulp and paper products can be considered to be standardized and at the maturity stage of the product lifecycle. They are commoditized, which is reflected in that market growth in western Europe and North America is below GDP growth or even negative for some products; price differentials between suppliers are marginal; switching costs are low; and much of the negotiating power lies with the customers. However, this does not mean that technological and product development in pulp and paper products has stopped – continued product refinement and advances in production technology are currently being conducted in the sector.

The structural changes in the global and western European pulp and paper markets mainly caused by digital media and increasing competition from the emerging economies, is one strong incentive to renew the European pulp and paper sector. Indeed, in recent years, the pulp and paper companies in western Europe have diversified their strategies and started to produce new products (e.g. second generation biofuels and dissolving pulp). Chapter 4 will address the 'New Forest Products' in more detail. It is evident that these new products and related services (Chapter 5) can provide significant opportunities for the forest-based sector, and European societies in general for the desired move to bioeconomy or green growth in the coming years.

In the coming decade, the big challenge for the western European pulp and paper sector and the forest sector dependent on it seems to be the 'transition period' or the

period of *creative destruction*. That is, the period when some of the current products may be declining or stagnating, but the new emerging products are not yet big enough to offset the loss of revenue from the current products. Here, the measures that boost the cost-effectiveness of the current products and those that speed up the transition to new products are essential.

Wood products markets

The wood products sector has large significance for wood resource flows and many regional economies in Europe. Since 2008, the markets of large-volume wood products have been severely affected by the global financial downturn. Despite the continued period of low economic activity in Europe, the long-term prospects of the wood products industry are often seen as promising. For example, the political interest in using wood products to achieve climate change mitigation targets, as well as the recent technological and institutional changes, have resulted in new investments and improved cost competition for new wood-based construction solutions. In general, the positive prospects for the wood products industry are related to the expectations for a shift towards low-carbon economy favouring renewable resources. However, very little systematic research has been carried out regarding the specific factors and mechanisms that could realize these expectations. However, there are only few studies that address the long-term outlook for the European wood products markets.

This chapter provides a synthesis of the long-term prospects for the wood products markets in Europe and discusses the emerging trends that have received less attention in the existing outlook studies.

Need for wood products outlook re-assessment

The wood products industry can be divided into three subsectors, sawnwood, wood-based panels and engineered wood products (e.g. for construction, furniture and packaging). The major demand determinants are related to prices, the level of household income and construction activity. Typically, outlook studies focusing on wood products only focus on sawnwood and panels and rarely consider engineered wood products due to their small overall volume and heterogeneous nature. However, the sawnwood sector is also seen to profile the market development of the smaller subsectors. According to FAO statistics, the production of sawnwood in the EU27 totalled 98.6 million m^3 in 2012 with an estimated value of EUR 20.5 billion. The wood use for sawnwood production in the EU27 totalled around 184 million m^3 in 2012, which was clearly more than a half of the total industrial roundwood consumption. The nearly 100 million m^3 worth of sawmill chips, sawdust and other residues left over from sawn wood production provide raw material for diverse uses, including wood-based panel production, bioenergy and pulping.

Most forest sector outlook studies, including the EFSOS II study from 2011, suggest relatively slow growth for sawnwood markets towards 2030. However, the construction sector in Europe has been experiencing an exceptionally severe and long lasting recession in recent years, which has also been mirrored in the wood products markets. The economic crisis caused them to plunge in 2008 and continued to stagnate for six years, but with some signs of recovery in 2014. None of the long-term outlook studies for

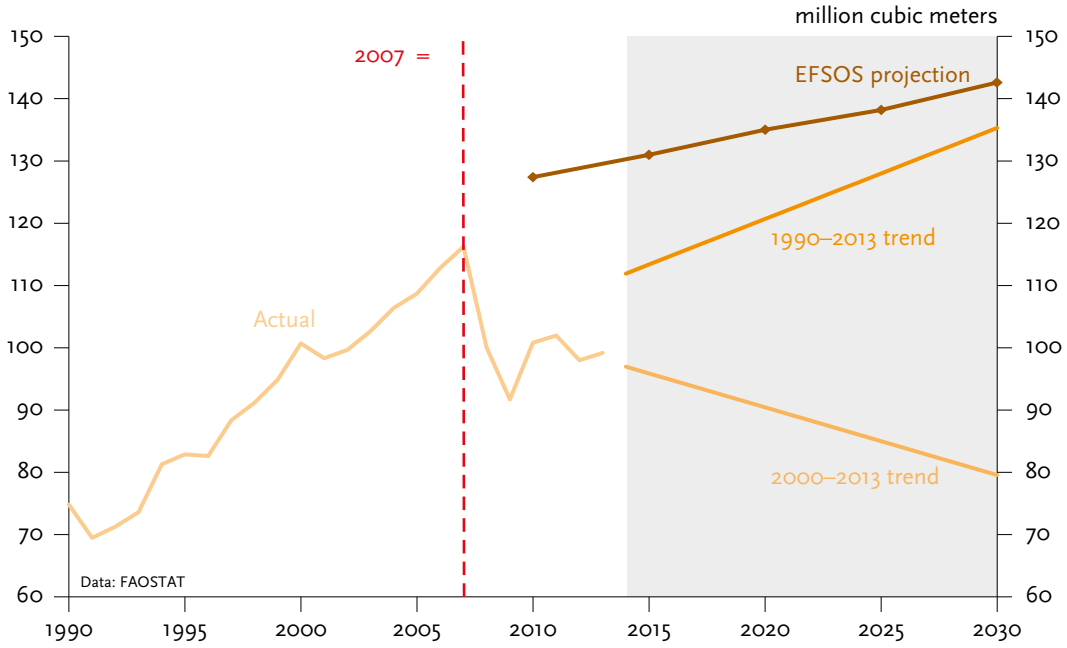

Figure 4. Sawnwood production in Europe in 1990–2013 and projections to 2030 (excluding Russia).

European wood products sector have captured the consequences of the continued economic downturn on the wood products markets. As a result, the previously published projections (e.g. EFSOS II) for sawnwood production are significantly higher than the trend projections based on the latest available data (see Figure 4). For sawnwood *consumption*, the patterns and projections look rather similar. Although the development in 2008–2013 is significantly due to the cyclical economic recession, it may nevertheless have longer-term structural consequences. In Finland, for example, the sawnwood capacity has been reduced by one third – and it is a question of how much of it will return when the economic upturn starts. There has also been a move towards more value-added engineered wood products, which could turn out to be a long lasting trend. In summary, it will be important to update the previous outlook studies to take into account the impact of the long-lasting economic slump and its possible structural impacts.

The growth rate in panel markets has clearly exceeded the growth rate of sawnwood, most notably in central and western Europe. The competition between sawnwood and wood-based panels may also continue in the future; however, wood-based panel production depends on the sawmilling residue supply and also competes for the same raw material with the energy sector. Only an extreme assumption of tripling sawnwood wood consumption in the EU would increase the residue availability for the cascading uses significantly – at a scale of 50–100 million m^3 by 2050 from the 2012 level.

In general, the future outlook will depend mostly on the demographic and economic development in Europe, on the export market demand, and on the competitiveness between the European wood products producers and other regions. The outlook studies seem to have clearly underestimated the pace of change in the global competitive advantages. The markets have been shifting from West to East at a pace not anticipated by

the outlook studies, driven, for example, by faster economic growth and smaller labour costs in the eastern emerging economies. Indeed, the competition between eastern-European, Russian, and Chinese producers, both in the European markets and in the export markets outside Europe, are likely to increase.

Sawnwood demand development a big question mark

The long-term historical trends for population and economic growth do not seem to support strong growth prospects for the demand of wood products in Europe. If the growth rested only on these drivers, we could expect the sawnwood markets to start growing again after several years of stagnation, along the projections by UNECE/FAO, i.e., from zero to one per cent per annum. However, a rate of growth this low would have limited impact on employment, wood use, or market structures over the coming decades in Europe. Consequently, the high growth prospects in the demand for European wood products in the long run seem to rest mainly on structural changes in the *consumption per capita*. Such an increase would seem plausible mainly through changes (substitution) in the market shares of different construction materials and practices.

In the past, structural changes seem to have occurred mainly within the wood products sector itself. Specifically, wood-based panels are substituting sawnwood, while engineered wood products have managed to replace steel, bricks and concrete in construction, but only to a small degree. Nevertheless, in some countries, such as in Finland, Estonia and Austria, large scale substitution practices in construction seem to have occurred. For example, the sawnwood consumption in Finland doubled in the 1990s from 0.5 to 1 m^3/capita; in Estonia, the change has been even more notable. Some of the reasons for the increase seem to be policies and objectives to promote wood construction as well as the new technological and business innovations in wood construction that have made it more cost competitive. Despite these few examples, the sawnwood consumption in the EU has on average stayed five times lower compared to Finland, i.e., below 0.2 m^3/capita. However, the above few examples raise the question whether similar developments could also occur in a larger scale across Europe in the future, and what could cause such an increase to happen.

Prefabricated wood construction outlook promising

The lack of major changes in the use of wood in Europe seems to be at least partly explained by the culture and characteristics of the construction sector. The accustomed building practices are favoured over alternatives due to a slowly changing construction culture, institutional setting and industry structure. However, it would be misleading to conclude that the future prospects were only affected by past trends and that no changes were possible. Instead, the major changes in the global operating environment are very likely to also affect the construction sector in the long run. There is thus a need to find alternatives for the current resource and energy intensive building practices in the same way that there is a need to reduce the reliance on fossil fuels in the energy sector. The newly emerging prefabricated wood construction practices might offer one solution for the major challenges that the construction sector is facing.

Few radical improvements for the productivity of construction have occurred since the adoption of steel reinforced concrete and standardized elements that revolutionized

the construction sector in the last century. For this reason, high hopes are placed on the newly emerging wave of the industrialization of construction. By taking the lead in the industrialization trend, the wood products sector also has the opportunity to enter markets where the use of wood has traditionally been low, such as multi-storey and non-residential construction markets.

The terms 'industrialization' and 'prefabrication' refer to the efficient, factory-like construction and assembly of building modules or even complete single family houses. In the extreme case, massive wood elements made of engineered wood products, such as CLT (cross laminated timber), can be used to make an entire room module with all the engineering and finishing work done at the factory so that they can be assembled into a multi-storey building at the construction site, just like giant Lego blocks. This brings many benefits compared to the traditional on-site construction practice. For example, the assembly is done indoors, in a dry and clean environment, which allows efficient moisture and quality control. Moreover, the production produces less waste and the construction phase is safer for the workers. The rate of prefabrication is also positively linked to producing more value added for the wood construction products due to the larger need for knowledge-intensive services and the efficient combining of several work phases in a single location. More importantly, however, prefabrication reduces building costs due to optimized assembly and its simple and quick construction phase. Consequently, wood-based solutions can be cost competitive when comparing the total costs of construction, even if the wood raw material itself would be more costly than concrete. Although prefabricated wood modules have been introduced to the markets only very recently, the growing number of completed projects and 'learning-by-doing' through experience will enhance the practices and help to bring down the costs even further.

It seems that it would be difficult, at present, to implement similar improvements in construction productivity by using the other conventional building materials. One would expect, therefore, the construction sector to take increasing interest in the emerging prefabricated wood construction practice, particularly if the pioneering building projects turn out to be successful, and that the cost efficiency and other benefits can still be improved with experience.

It is interesting to see if the emerging prefabricated wood-frame multi-storey building concept will begin to follow a typical S-curve type of a product life-cycle diffusion phase. In this case, the introduction phase is followed by rapid growth that is building on accumulating experiences and the positive customer experiences snowballing in the markets. The data so far seem to suggest that this could be the case. For example, the production of CLT has grown around 15% annually in Europe during 2008–2012, despite the economic and construction recession. This trend is in strong contrast to the mature sawnwood markets which have closely followed the business cycles over the past decades. In Finland, the share of wood as the frame material in newly constructed multi-storey buildings has been less than one per cent in the past decades, but has recently increased markedly and was 4.5% in 2013. The Finnish government policy to enhance wood products has set the target to increase it to 10% by 2015 and this is likely to be achieved based on the number of projects in the pipeline and under consideration.

While these examples represent large changes in the construction sectors in some countries, the effects on the European wood products industry on the whole have so far remained small. The traditional sawnwood products and markets still dominate the European overall wood products production volumes, employment and income generation as well as roundwood consumption.

Future holds diverse opportunities for the wood products sector

Technically, the market share of wood could be increased in all sectors of construction involving structures and buildings with less than forty floors – that is, from bridges and windmills to industrial halls and skyscrapers. Technical considerations, thus far, do not seem to be a limiting factor for the potential growth of wood products. However, in Europe the level of new construction is low, mainly because the population growth is stagnating or even declining with household sizes already stabilized to a great extent. On the other hand, the most important growing markets will be in the renovation sector due to the large number of old buildings in Europe in nee d of renovation, maintenance and improving energy efficiency. Wood façade renovation concepts have already been standardized and adopted into use. Moreover, the still continuing urbanization trend might create a market for additional storey construction, in which one or two storeys are built with prefabricated modules on top of an existing building.

Most of the above mentioned new markets are an option for the largest companies with enough resources to bear the financial risks of bringing new products to markets, and keeping the capital fixed for long periods of time required by the construction processes. For these companies, ensuring the successful implementation of new types of construction processes may require taking steps towards managing a larger share of the construction value chain, and with that also the related risks. However, while SMEs with limited solvency do not have these options, they can still act as subcontractors in these projects. Many of the SMEs, however, are likely to continue producing different sawnwood grades, for which there may be increasing cost competition from the emerging economies. This growing competition could further drive the industry to consolidation and specialization.

In many parts of Europe, the use of wood in construction has remained a curiosity, compared to building with stone, bricks or concrete. Due to the regional differences being deeply rooted into cultures and traditions, it seems very unlikely that large scale substitution would occur rapidly in Europe. Over time, it might be possible to increase wood construction also in regions where the rate of wood use has historically been low, but may require adopting completely new types of composite material technologies where the use of wood is less central.

Different materials in construction and furniture manufacture are rarely used on their own, but rather in combination with other materials. In the future, this could have important implications for wood utilization. For example, the prefabrication concept based on the mechanical modification of wood into desired shapes could be but one stepping stone towards utilizing wood-based fibres and fibrils with other materials and binding agents. Wood-based fibres could be used, for instance, to replace the resource intensive steel bars, and the much more expensive carbon nanotubes used for strengthening concrete structures. In practice, it could be realized for example with the already established technologies of 3D printing or extrusion. For some end uses, such as non-mass-produced decorations and furniture, 3D printing could decentralize production into private homes.

Also, the properties of the conventional construction products are unlikely to remain unchanged in the long term. In general, often reported improvements for the large volume construction products, most notably for concrete, are related to the strength, lightness, durability, recyclability and the reduction of carbon emissions, as well as the improved insulation capacity and functional properties of the material. The cost-efficient

production of graphene and carbon nanotubes that would revolutionize almost every field of industry, for example, is still far in the future, being currently of interest only for a limited number of uses. As it will probably take decades for the emerging breakthrough technologies to reach the volumes of steel reinforced concrete markets, it could possibly lend a competitive advantage to industrialized wood construction solutions, at least in the coming decades.

Conclusions and implications

Based on the conventional demand indicators, i.e. population and economic growth, major increases in the sawnwood market volume in Europe seem unrealistic over the coming decades. Since the wood products markets are likely to remain largely dominated by the sawnwood and wood-based panel sectors in the medium to long term, the prospects are also similar for the impacts on the sector's production value, employment and wood consumption. Even though there are many arguments for favouring wood in construction, including climate change mitigation, the renewability of the material and the possible positive effects on human health and indoor air quality, it appears likely that the cost factor will continue to play a major role in the competition between different construction materials and practices also in the future. In this respect, the recent improvements in the cost efficiency of the prefabricated wood construction modules and systems seem promising. These newly emerging engineered wood products and industrialization trends have the potential to transform the sector in some countries, where there are already long traditions in wood construction and high economic and political interest to utilize wood resources. In the time scale of many decades, larger scale structural changes are also possible as well.

Adopting the use of wood for large-scale, multi-storey construction throughout Europe would not necessarily increase wood consumption to a very large extent due to the relatively small amount of wood needed for one apartment. Nevertheless, it would create significant value added and employment for the sector. Also, it is important to note that wood alone cannot – and is not likely to – satisfy all the needs for Europe's infrastructure. Therefore, instead of thinking of ways how to maximize wood biomass use, the more critical question is how to minimize the environmental impacts of construction and maximize the needs of society in a holistic way by combining different materials and exploiting their best properties.

Scenario thinking and detailed analysis of the drivers of change will be required to better understand the effects of the trends and decisions taken today. Some of the most important trends can already be identified, including industrialization, ICT development, material technology and regulations and regimes, yet their impacts on the built environment are very uncertain. The sector needs to keep track of the possible developments and prepare for the changes, even if steel reinforced concrete would continue to dominate the construction sector and sawnwood would continue to dominate the wood products sector for the following few decades.

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3.

Forest bioenergy outlook

Riitta Hänninen and Antti Mutanen

Introduction

The renewable energy and climate change policies of the European Union (EU), i.e., the 20-20-20 targets and the recently updated targets for 2030, will impact and drive the demand for forest bioenergy for years to come. In the EU, the most important source of renewable energy is woody biomass, the share of which was 49% of the total use of renewable energy in 2010. In future, the absolute volume of wood consumed in energy production within the EU is likely to grow, yet the share of forest bioenergy of the total use of the renewables is expected to diminish due to the rapid development in the use of alternative renewable energy sources, such as wind and solar power.

The expected growth in the demand for forest bioenergy has raised the question whether biomass can be procured from European forests sufficiently and sustainably. For instance, the widely cited EUwood study suggests a shortage of forest biomass within the EU until 2030. The result is mainly based on the assumptions that the 20-20-20 targets are fulfilled, forest bioenergy still plays a major role in the use of renewables, and the production of traditional forest industry continues on its historical growth trend. The recent European forest sector outlook study (EFSOS II) also stresses the tightness of the supply of forest energy in future. However, some of the later studies, and the analysis in Chapter 2 of this report, indicate the need to reassess these results. Also, the development of energy efficiency may reduce the need for forest biomass in forest bioenergy energy production.

Future demand and supply potentials of forest bioenergy has been assessed in several studies. However, the variation of the results is wide, and significant uncertainties are related to the assessments. In this chapter, the aim is to provide a synthesis of some of the major European forest bioenergy assessment studies, provide insight into interpreting the results arising from these, and to discuss the future outlook of forest bioenergy in Europe.

Complexity of assessing forest bioenergy markets

The assessment of the future supply and demand of forest bioenergy is a complex issue. This is due the interlinkages in wood use and flows between the different wood-processing industries, and the fact that forest industry is also a significant producer of bioenergy. For forest bioenergy assessments, therefore, it is not enough to focus only on the

forest bioenergy production, but also to analyse the implications of the forest industry's development to biomass supply and bioenergy production. For example, sawmills are in a key position as mobilisers of all kinds of forest biomass, sawlogs, pulpwood and forest residues from the forest to market. Sawmills also provide industrial by-products to be used in the other fields of the forest industry and energy production, which have already caused competition between material and energy uses.

In the existing assessments, competition between material and energy uses of wood is often not considered adequately. Typically, it assumed that wood goes first to material use in traditional forest industry production, and only after that the wood raw material which is left goes to energy use. This assumption is also in line with the concept of *cascading use of wood* promoted, for example, by the European Commission. In reality, however, and based on how markets work, this assumption may not hold. Competition will change market prices and the volumes transacted will adjust accordingly between the different uses of forest biomass. Of course, as there may be no forest industry or competing use of the forest biomass in some regions, one cannot determine the order of material flows strictly beforehand.

Another issue requiring a more detailed analysis is the impact of new innovative products and concepts (e.g. biorefineries) on the use of forest biomass. For example, as technologies are evolving, older facilities are being rebuilt or completely new ones established, and new technologies to produce energy products from woody biomass are emerging. This will most likely improve the energy efficiency of forest bioenergy production significantly and the biomass consumption per unit of energy output will decline. At the same time, the development of harvesting and transportation technology and logistics may improve the competitiveness of wood-based energy; further, forest resources that have earlier been deemed unprofitable to exploit may turn out to be economically potential sources of raw material. Hence, the technological development may have both significant negative and positive effects on the demand for wood biomass.

The import volumes of forest biomass used by the forest industry and for bioenergy production are already considerable in the EU. For example, wood pellet imports from North America to Europe have doubled during 2011–2013. The large pellet investments in North America will allow this growth to continue also in future, which may also affect the price levels of forest biomass in Europe. However, in some of the extensively cited European forest bioenergy assessments, international trade in woody biomass is not considered at all.

Recently, the issue of carbon neutrality and biodiversity impacts of using wood for energy production have been raised in several fora. The changes in the direction of public opinion and policy measures concerning forest bioenergy, and the use of forests in general, may have unforeseen impacts on the future competitiveness and availability of wood for energy. This can also affect the future demand for forest bioenergy and supply potential.

The potential effects of climate change on forest growth should also be considered. In the long term, the effects may be significant and should be deliberated, for example, in outlook studies reaching to 2050 and beyond.

In addition to the above issues, there are several other factors that, depending on the study, may or may not have been addressed in detail in the forest bioenergy assessments and outlooks. Moreover, the terminology, approaches, focuses, constraints, estimates and conclusions may vary considerably between the studies. Thus, it is no surprise that the readers of the reports and the users of the estimates may have somewhat different and even ambiguous understandings of the future outlook of forest bioenergy demand and supply in Europe.

Scenarios for forest bioenergy demand and supply

In the following, we try to provide insights into interpreting the results of recent European forest bioenergy assessments and scenarios. Especially, different approaches, models, and other critical factors causing variation in the estimates are pointed out and discussed.

In the EU, the total use of woody biomass in 2011 was estimated to be 942 million m^3, of which the energy use of wood was over 300 m^3.[1] During the last decade, the growth rate of the use of wood for energy has exceeded the growth rate of traditional material use, and if this trend continues, energy use will surpass material use possibly already before 2020.

Some recent estimates for the potential demand for (use) and supply of (resources) forest bioenergy for the EU from 2010 until 2050 are provided in Table 5. As seen, the estimates vary considerably between the studies. The high variation is a common feature of forest bioenergy assessments, and it seems that the variation remains regardless of the geographical scope of the studies.

As to the variation in demand side assessments, the estimates may or may not include the whole range of energy use such as households, forest industry's internal use, large-scale CHP, etc. Further, the estimates may only focus on some specific segment of its energy use like large-scale heat and power. Moreover, the estimates for future forest bioenergy demand may be based on fulfilling the EU policy targets, on simple trend projection or on more sophisticated modelling also taking into account competing energy sources.

Some of the demand estimates do not consider the availability or supply of wood and its costs, which also affects its demand. While such an approach simplifies reality, it can be applicable if the aim is to only demonstrate the computational effect of the fulfilment of policy targets on volumes, for example. However, such an estimate can hardly be regarded as a 'realistic forecast' for actual market volumes transacted in the future.

In the assessments of supply or resource potentials, three different concepts are commonly used: theoretical, technical and economic potential. *Theoretical potential* is the maximum amount of woody biomass production under only the most fundamental biophysical limits such as rainfall and soil fertility. However, common to most forest bioenergy potential assessments is that the volume of woody biomass available for energy use is assumed to be the amount that remains after the traditional use of wood is first accounted for. Thus, the forest bioenergy potential is dependent on, and subordinate to, the material use by the forest industries. Moreover, the theoretical potential of primary and secondary forest residues is typically defined as their total production which, in turn, is dependent on the level of fellings and the production of forest industry products. *Technical potential* describes the potential that is available when theoretical potential is subjected to technical constraints such as steep slopes and availability of suitable machinery. *Economic or market potential* is technical potential subjected to economic criteria such as production costs, energy prices and profit margins. Thus, the consecutive order of potentials reflects the transition from a purely theoretical assessment of the availability of forest bioenergy to more realistic ones. In practice, the exact definitions of the forest energy potentials vary between studies. For example, sustainably criteria or

1 These figures, however, include several sources of uncertainties, as well as some double counting due to the cascade effect, i.e. the residues of one sector are counted as raw material for another sector.

Table 5. Forest bioenergy demand and forest biomass supply assessments.

Region and study	Time frame	Estimate, EJ/a	Estimate, Mm^3/a	Type of estimate	Origin of biomass
Demand/Use					
EU27: Mantau et al. (2010a)	2010	3.1	346	wood consumption for energy generation	not specified
EU27: Mantau et al. (2010a)	2020	5.0	573	wood consumption for energy generation	not specified
EU27: Mantau et al. (2010a)	2030	6.6	752	wood consumption for energy generation	not specified
EU27: Lauri et al. (2012)	2030	-	390–600	use of wood in heat and power production	primary, secondary and tertiary residues, material wood
EU27 + NO and CH: Moiseyev et al. (2013)	2030	*	151–256	use of wood in heat and power production	primary residues, industrial wood
Europe excl. Russia: UNECE/FAO (2011), EFSOS II	2030	-	435–857	energy use of wood	not specified
Supply/Resources					
EU27: Asikainen et al. (2008)	2005	1.5	187	forest energy potential	primary residues, surplus forest growth
EU27: Mantau et al. (2010a)	2010	3.9	450	sum of different kinds of potentials	primary, secondary and tertiary residues + landscape care wood; scen. A1, medium mob.
EU27: Mantau et al. (2010a)	2020	4.5	514	sum of different kinds of potentials	primary, secondary and tertiary residues + landscape care wood; scen. A1, medium mob.
EU27: Mantau et al. (2010a)	2030	5.0	573	sum of different kinds of potentials	primary, secondary and tertiary residues + landscape care wood; scen. A1, medium mob.
EU27: Moiseyev et al. (2011)	2020	0.2–4.4	23–505	maximum potential supply	primary and secondary residues, roundwood and residues from complemetary fellings, competitive use of wood, wood imports
EU27: Moiseyev et al. (2011)	2030	0.2-3.1	23–356	maximum potential supply	primary and secondary residues, roundwood and residues from complemetary fellings, competitive use of wood, wood imports
East and West Europe: Smeets & Faaij (2007)	2050	7.4	638	theoretical potential	primary, secondary and tertiary residues, surplus forest growth
East and West Europe: Smeets & Faaij (2007)	2050	7.3	629	technical potential	primary, secondary and tertiary residues, surplus forest growth
East and West Europe: Smeets & Faaij (2007)	2050	5.9	509	economic potential	primary, secondary and tertiary residues, surplus forest growth
East and West Europe: Smeets & Faaij (2007)	2050	4.7	405	economic-ecological potential	primary, secondary and tertiary residues, surplus forest growth

Note: conversion factors (GJ/m^3) vary between the studies. Higher and lower heating values for dry and moist (e.g. 40 %) wood are applied.
* 73 085 – 128 845 GWh of electricity and 542 303 – 897 289 MMBtu of heat.

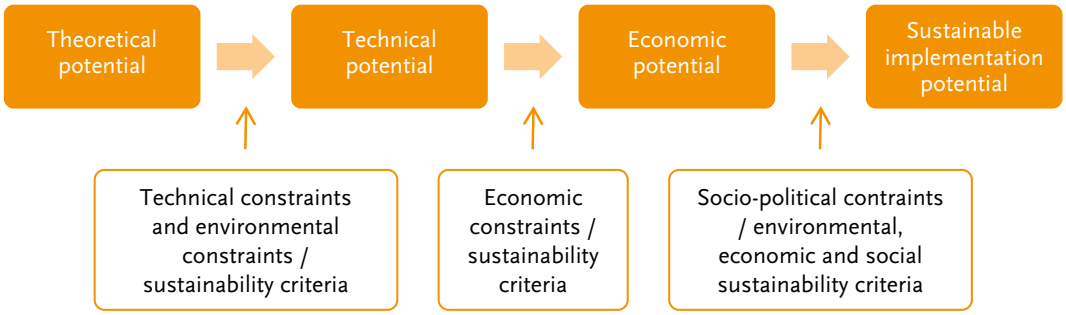

Figure 5. Example of categorisation of forest bioenergy potentials and the constraints.

socio-political constraints can be integrated into different potentials. Moreover, additional study-specific potentials are common such as implementation or economic-ecological potentials. They are often intended to describe the more realistic availability or deployment of the forest bioenergy resource. The different concepts and sequence as well as the implementation of their constraints are illustrated in Figure 5.

The multitude and complexity of bioenergy assessments are not only related to the above-mentioned concepts, but also to the fact that there are a range of approaches and methodologies that have been employed. Three different approaches are typically distinguished: *resource-focused* (supply-driven) assessment, *demand-focused* (demand-driven) assessment, and *integrated assessment* modelling.

In the resource-focused approach, the focus is on the forest resource base and on theoretical and technical potential. The demand-focused approach also takes into account the forest bioenergy demand side; the aim is to assess economic or 'the most realistic' implementation potentials. On the other hand, in integrated assessment modelling, the focus is on policy questions concerning climate change; atmospheric emission's feedback to the environment; and socio-economic drivers and their impacts to the potentials. Depending on the approach, the methods employed include statistical analysis, spatially explicit analysis, cost-supply analysis, economic modelling and energy systems modelling, etc.

The different approaches and methodologies applied in bioenergy resource assessments have both strengths and weaknesses. *Statistical analysis* used in the demand-focused approach is typically simple, transparent and data requirements are modest; however, it is rather limited as it ignores economic mechanisms and the level of detail, especially spatially. *Cost supply analysis* is also transparent and provides results that are typically easy to interpret, but again ignores market mechanisms and price adjustments. *The energy system models* and other economic models focus on market mechanisms, especially on the interaction of supply and demand; as a downside, however, spatially detailed results are usually not available. Also, the integration of energy production and overall economic activity with climate change and the possible feedback to economic drivers is ignored, as are the soil characteristics and land-use forms contributing to the availability of forest biomass.

Integrated assessment modelling takes into account 'all the relevant aspects' related to bioenergy production, and thus allows a consistent evaluation of scenarios having several dimensions such as population growth, food consumption, trade flows, policy

measures and economic growth. A key advantage is the inclusion of feedback mechanisms and possible trade-offs in the analysis. Theoretically, these types of approaches and models, which include more aspects, effects and linkages, are superior to simpler ones. However, as the models became more complicated, the aggregation level and data requirements tend to increase. Moreover, the validation of complex models may become difficult and risks related to erroneous models increase. In general, as the complexity of the modelling system increases, the transparency of the methodology and results suffers. Accordingly, a large review study of bioenergy potential assessments concluded in 2010 stated that "no 'ideal' study using an 'ideal' approach that considers all aspects in a highly adequate way has been identified".

In summary, the variation of the estimates in forest biomass assessments is typically attributable to:

1) Differences in the types of forest biomass resources included. In some studies, for example, surplus forest growth and roundwood from extra fellings are taken into account and are aggregated with primary residues, while in other studies they are not included. The same is also true for stumps. Moreover, international and interregional trade in woody biomass may be considered or the regions may be regarded as isolated islands.
2) Differences in the theoretical, technical, economic or ecological constraints related to the supply of woody biomass for energy use. For example, technical constraints related to the rate of mechanization and technical development or to the characteristics of terrain may be considered and modelled at a spatially detailed level; or then they are taken into account using some conversion factor that can be labelled as an 'educated guess'. The development of conversion factors may also reflect the assumptions of technical development.
3) Differences in data. Data on key parameters and variables are uncertain or even missing. For example, figures for forest growth, residues recovery rates and the consumption and production of forest products and woodfuel vary between the data sources.
4) Differences in scope. Potentials may be calculated by using either demand- or supply-driven approaches, and the interaction of supply and demand is ignored. The time horizons may be different, as may be the assumptions related to the development of key parameters.

Forest bioenergy assessments and scenarios are typically future-oriented. Hence, assumptions about the development of models' key parameters are essential. In some of the studies listed in Table 5, the consumption of forest products is assumed to continue along historical trends. This has proven quite optimistic, especially in the case of some forest products such as graphic papers (newsprint and printing and writing papers). The assumptions of GDP development have also been overestimated compared to those realized in the recent years, and could be again in the coming years given the prolonged economic downturn in Europe. Finally, mapping possible futures and the assumptions of the development of key parameters always reflect the personal attitudes and feelings of the people involved in the research to some extent. Thus, it can be argued that some of the estimates for forest bioenergy are implicitly inclining towards the negative or conservative end of the range, while some estimates are more positive or optimistic. Although the assumptions on the parameters' development and many uncertainties are

crucial, sensitivity analyses are seldom provided or reported. It is also the researchers' responsibility to be more transparent and cautious when drawing conclusions and implications from the assessments.

Outlook for forest bioenergy markets

Many of the assessments of future consumption and availability of forest biomass in Europe indicate a large increase in the use of wood for energy. Accordingly, a shortage, or at least a tightening, of the availability of forest biomass up to 2030 is expected. As mentioned above, a high level of uncertainty is related to these estimates since many important factors affecting supply and demand are not considered in the assessments.

The EU renewable energy and climate change policy targets are among the most important factors affecting the European bioenergy demand. Due to the policy targets, renewable energy sources will be favoured over fossil fuels. The abandonment of nuclear power in Germany will also be one of the supporting factors increasing the use of renewable energy sources, such as forest bioenergy, but also wind and solar power. Today, the relative prices of different energy sources finally determine which energy source is used, and this will be the case also in the future.

The current crisis in Ukraine is drawing criticism in the political arena of the EU's dependency on Russian energy resources. Also in Ukraine, the dependency on Russian energy is obviously seen as an acute risk. Both in the EU and Ukraine, bioenergy could be one solution in lowering the level of dependency on Russian energy. However, despite the regional abundance of forest and agro biomasses, raising the use of bioenergy requires investments, and in many cases also subsidies, which are dependent on political decisions and policy measures.

Changes in the energy markets are unpredictable. Recently, new shale gas investments have caused dramatic changes in the global energy markets. Cheap coal imported from the USA together with the low price levels of emissions trading have displaced forest bioenergy to some extent. On the other hand, policies advancing the replacement of fossil fuels with renewables, and possibly future high carbon emission prices, would imply higher demand for renewables such as forest bioenergy.

The European Forest Sector Outlook Study stresses the need to improve the mobilisation of wood and wood residues from the forests in order to meet the growing demand for forest biomass in Europe until 2030. However, factors affecting the balance between the demand and availability of forest biomass do not necessarily indicate a large gap or shortage. The forest industry's production has been stagnating, and the new forest products based on nanocellulose, microfibrills or composite woods, for example, tend to require significantly less wood raw material than traditional products. Further, the technological development enabling to increase energy efficiency will probably also decrease the need for forest biomass per unit of energy produced. The already considerable imports of forest biomass are also likely to continue in future, thus alleviating the possible shortage of biomass in the EU region.

Notwithstanding, global development patterns may affect biomass flows considerably and create significant uncertainty about the future supply and demand for forest bioenergy in Europe. In the long term, the Asian and Latin-American population growth coupled with the increasing number of middle-class consumers will increase the scarcity of biomass resources, at least in some areas of the world. This may increase demand

pressures also on European biomasses which could, in turn, speed up the investments to develop material saving technologies and new energy systems. One scenario could be that after a few decades, for example, Europe will be using its valuable forest biomass mostly for other purposes than energy, which will be produced based on other sources.

Conclusions and policy implications

This chapter provided insight into interpreting the results of forest bioenergy outlook assessments and the future prospects of European forest bioenergy development. The variation in estimates in these assessments is wide and comparisons between the studies demanding due to different concepts, methods and scope used. Depending on the study, the resulting trends of forest bioenergy availability and use may differ – the results being conditional to the models and procedures by which they were obtained. For policy, stakeholder and research purposes, it would be important to update the existing forest bioenergy outlooks for Europe.

The possible shortage of forest biomass, or a gap, between demand and supply indicated by the EUwood study for 2020 and 2030 (Table 5), for example, has been extensively cited and discussed. Although there are also other assessments supporting this result, we pointed out many factors that were not taken into account in these assessments, and which would most likely lead to lower estimates for biomass demand in the EU in the future. Moreover, it would also be useful to provide alternative scenarios that take into account the possibility of different energy infrastructures and developments. Rapid technological developments, supported by the EU, that are striving towards bioeconomy indicate a transition to new, more efficient climate neutral production methods. For example, the importance of energy sources, such as solar, wind, wave or sea biomass, could also increase with European forests and forest biomass being increasingly used for purposes other than for energy.

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4.

New products outlook

Annukka Näyhä, Lauri Hetemäki and Tobias Stern

The traditional forest-based sector in transition

In 1854, The Times of London offered to pay £1,000 to anyone who could develop a method of using rags as the raw material in papermaking. While this specific announcement did not produce the desired result, it clearly demonstrated the need to resolve the shortage of raw materials that was causing problems for papermakers and their customers. Today, 160 years later, the main challenge in the paper industry, or the whole forest-based sector (FBS)[1], is not so much the raw materials, but rather the need to develop new products and services – not only the existing ones.

In Chapter 2, many of the challenges facing the European FBS in terms of the structural changes in global forest products markets were highlighted. These challenges have been an important spark and motivation for the industry to start to renew itself. On the other hand, the global and European drivers related to the need to move to low carbon and sustainable bioeconomy and the polices supporting this objective, for example, are opening many interesting opportunities for the industry to move in new directions. In fact, it appears that that this mature sector is currently experiencing changes and transformations that are larger than it has faced over the last century.

It is important to realize that maturity does not necessarily imply a lack of opportunity or innovation: many mature industries have been transformed by new strategies, technologies, products and services. Currently, the forest industry is seeking to re-invent its strategies, products, services and business models, especially in the traditionally large forest industry countries in North America and western Europe. In short, the industry is diversifying its business strategies and product portfolios towards a variety of complete new products. These portfolios seem to be based increasingly on high value-added products and services rather than large-scale bulk production. Diversification and new product portfolios also mean that the industry is entering into totally new markets with the creation of new networks and customer bases.

1 Traditionally, the concept of the *forest sector* has been used to describe the forest industry, including the pulp and paper industry, the wood products industry and forestry related to these. However, in the 21st century, the wider concept of the *forest-based sector* has also become popular. This reflects the fact that forest industry companies, and also companies from other industry sectors, are increasingly developing new products and services based on forest biomass, such as bioenergy, raw materials for textile industries and other biomaterials, which can be used in a variety of industry and consumer goods sectors

The re-innovation process of the FBS in western Europe has only taken off seriously in the last 5–10 years with the transition process taking place gradually over the coming decades. Despite this, the drivers and challenges of this transition period are widely recognized – there are many important questions, uncertainties and alternative future paths related to the development that need to be addressed more than has been done so far. For example, given the large number of new products that are technically possible to produce, the question is to establish the economically viable ones. Where would the new products be produced? What roles and what kinds of competitive advantages would different regions have in the value chain? Will the value chain be centred in one country or in several, or be the responsibility of one or many companies, as has been the case in the electronics industry, for example? For instance, will the emerging economies be mainly the large scale producers while the OECD economies primarily focus on high value-added products and services? What role will the new industries, sectors and investment groups play outside the traditional FBS in the development of the new products and services? What would be the implications of new products development on, for example, wood demand, policies and FBS strategies in the future?

To date, the research and discussions related to the transition have been very much on technological issues such as which products are technologically possible to produce and when. However, at the time when some of the new products are already entering markets on the commercial scale, the importance of questions related to competitive advantages in the value-chain, business strategies, policies and their implications are heightened.

This chapter focuses on the development of the new forest-based products, giving examples of the different opportunities and challenges related to these, and their implications for the FBS. We do not intend to answer the questions raised above; rather, we aim to provide background analysis and information that may help address these and other questions that need to be addressed in more detail.

Biorefinery is a platform for transition

There has been plenty of interest towards *forest biorefineries (FB)*, particularly in countries with high-quality R&D, a mature state in the forest-based industries and abundant lignocellulosic biomass resources. A forest biorefinery can be defined as a multi-product factory that integrates biomass conversion processes and equipment in order to produce bioenergy (e.g. biodiesel, bio-oil, bioethanol, green electricity, heat and pellets) and bioproducts (e.g. bio-composites, bio-plastics) from wood-based biomass. The FB can use multiple feedstocks, including pulpwood, harvesting residues, extracts from effluents, fractions of pulping liquors, as well as recycled paper and industrial wastes. It can be a large-scale industrial facility, integrated into a pulp and paper mill, or a medium- or small-scale facility integrated into a sawmill or plywood mill (most of the discussions have focused on the former). An important goal of a forest biorefinery is to more efficiently utilize the entire potential of raw materials and by-streams of the forest-based sector for a broad range of products.

Like petrochemical refineries, a forest biorefinery can produce both low value-high volume and high value-low volume products in order to make its operations economically feasible. For example, various high value-added bio-products could play a prominent role in the portfolio in addition to biofuels. These high value products may include fine chemicals, food additives, pharmaceutical products or dietary supplements as well as carbon fibres or (cellulose) nano-fibres, which can be used in high value composites.

The biorefinery conversion technologies can be classified into three main pathways: bio-chemical, thermo-chemical and physical-chemical, which can also be combined to some extent. Some of the conversion technologies are already mature and commercial, whereas others still require development before they become commercial applications. There are a number of different product and technology possibilities; however, no *one-size-fits-all* solution seems likely. Incorporating a biorefinery unit within an existing pulp and paper mill has significant technological, economic and social advantages over the construction of a green field stand-alone biorefinery. A biorefinery is also a natural platform for the traditional forest industry to gradually move to new products. Indeed, the development of new products is largely based on the revenue from existing forest products. In fact, the pulp and paper industry is already doing this by steering its strategies and investments in this direction.

Several countries in Europe, particularly in northern and western Europe, are active in the commercialization of advanced biofuels, both through thermo-chemical and biochemical conversion. Germany, Netherlands, Denmark, Norway and Finland have the highest number of biorefinery facilities either in pilot or commercial scales. However, these biorefineries are not only forest biomass based, they are agriculture and waste biomass based. As of October 2013, there were 30 biorefinery facilities in operation or under construction, of which 23 will use lignocellulosic biomass. The majority of these are pilot or demonstration facilities using lignocellulosic biomass as the raw material. Eight of these utilize thermo-chemical conversion route and 18 biochemical conversion technologies. Overall, it appears that in future, there will be a range of biorefineries of different sizes utilizing several types of biomass feedstock and technology options.

Many countries have the potential for success in the forest biorefinery business. It also seems that countries interested in the biorefinery business have many common issues that they consider as their particular strengths. Thus, the realistic identification of unique strengths and the continuous development of competencies is crucial at the national level. Forest biorefineries are considered an environmentally and economically sustainable new business opportunity in many studies. Nevertheless, in addition to considerable opportunities, there are also many challenges. As the biorefinery industry is at the stage of making the shift from pilot demonstration to commercial activity, several questions related to their future prospects should be considered. Under what circumstances is forest biorefinery profitable? What are the socio-economic implications to the forest sector at both the national and global levels? What are the environmental impacts? What linkages do biorefineries have with other forest-based industries? What are the most sound and cost-efficient policies that could support biorefinery development?

Wood products: the potential for a breakthrough

The wood products industry is much older than the paper industry, and in this sense even more mature. However, in the last decades, there has been a number of technological, process and business developments in wood construction in Europe as discussed below. Likewise, advances in wood modification technologies are improving the durability and creating opportunities for the use of temperate hardwood in a wider range of exterior applications. There are also great potential for structural uses of hardwood in interior construction and furniture design. There are also high hopes that political targets for moving to low carbon bioeconomy will support wood raw material-based

construction, in particular. Wood building materials are likely to have greenhouse gas mitigation benefits unlike other building materials such as concrete and steel. The sector itself has high hopes that this will also materialize in future as a major driver for the increasing demand for wood products.

As indicated in Chapter 2, wood-based construction systems have now been technically proven for multi-storey buildings, instead of being limited to small-scale buildings and single family houses, as in the past. Particularly, *prefabricated engineered wood products* have transformed wood construction in many ways. Engineered wood products (EWP) are made by bonding (usually with glue) lumber, veneers, strands or fibres together to generate dimensionally stable products for various construction purposes. Large structural EWP solutions, such as pillars, elements and modules, can be used for single family houses, multi-storey buildings or other constructions such as bridges.

One of the most promising EWPs is the *cross-laminated timber (CLT)* element and module (see Chapter 2). Some of the major advantages related to CLT elements and modules is that they extend wood construction into new areas, particularly to multi-storey buildings. Also, the process and product concepts developed around CLT modules have allowed wood construction to move to factories instead of building sites, as well as transferring the industry to high value-added products. The CLT module business is much closer to the construction industry than traditional sawmilling. For example, a CLT module consists of various value-added services such as planning and other know-how (engineering, architecture and design, and technical work related to electric wiring and plumbing, etc.). As regards the future prospects, perhaps the most promising factor with CLT modules is that it can be a cost-competitive substitute for concrete elements, with some additional benefits that were elaborated in Chapter 2.

What future developments will be seen in the wood construction and furniture sectors? It is expected that there will be a continuing development towards a more versatile use of wood: a variety of integrated prefabricated building systems, including hybrid and composite materials, will be developed. Also, new protection giving designs, surface treatments and bio-based material concepts that allow easy and low-cost maintenance, could be brought to the markets. For example, one interesting development is the design concept that could take into account changing building services during the building's lifetime. It also appears that many value-added products based on recycled wood could enter the markets. There have also been discussions on adding intelligent properties to furniture – elements can be adjusted for the changing needs of the ageing population, for instance.

Nevertheless, it needs to be taken into account that the future potential of wood construction and the success of wooden buildings are not only dependent on technological advancements, many institutional issues also have a crucial impact on its development. Along with the development of factory-made, prefabricated solutions in wood construction, there is a need for the standardization of construction systems and practices as well as an update of the fire regulations. Likewise, new educational needs must be considered; for instance, there is currently a lack of structure designers and architects with expertise in wooden buildings. Also, climate policies, energy efficiency requirements and health issues will affect future prospects. It appears that the multi-storey wooden buildings that are currently being built will have a significant pioneering role in demonstrating the functionality, safety and profitability of the concept, both for the construction industry and its customers. In summary, it seems that we are only at the starting phase of a potentially very promising development for the European EWP industry.

Figure 6. Illustration of some forest product developments and their end uses.

Sustainability is driver for packaging and hygienic products

Packaging and hygienic products are very different from biofuels or wood construction products in terms of product qualities, distribution channels and end-uses. The forest products industry is, in all respects, a highly diversified sector. Wood and fibre-based packaging materials made of recycled and virgin fibres provide protection for different products ranging from food and liquid to a variety of other consumer goods. Today, one important driver of packaging development is *environmental sustainability*, the need for these products to leave as little an environmental footprint as possible. Also, issues related to distribution efficiency, marketing power, commercial advantages, consumer safety and convenience also need to be considered. These drivers have provided incentives to develop the technical properties of forest-based materials in packaging.

Added functionality and communication properties in packaging, i.e., smart and interactive packaging, are rapidly emerging. Printed intelligence consists of different components that can extend the functions of printed matter beyond traditional, visually interpreted texts and graphics. They can also carry out different actions as a part of functional products or wider information systems. Today, added functionalities are often based on labels such as RFID tags and laminated solutions. Many new printed intelligence solutions are currently appearing on the markets. Examples of intelligent packaging and printed products are packages that indicate when the contents are past their 'use-by date', or when they are ready for consumption. Intelligent medicine packages that remind about the timing and correct doses for taking the medication have also been developed. In future, it is believed that packaging solutions will be further developed with information systems, for example, that are connected to a consumer's domestic systems (e.g. internet-connected refrigerators). It is also possible to print electronics on paper or board surfaces. Examples of potential future solutions are electronic wallpapers, product identification systems, intelligent sensors, batteries integrated into packaging systems as well as sensors and fuel cells integrated into textiles.

Currently, packaging materials based on bio-based polymers are at the pilot phase with some even on the market. Indeed, there is plenty of potential to modify wood fibres by adding different chemical or nanotechnology solutions in order to create new types of packaging and hygiene products. It is expected that in the future, new healthcare products with improved softness, higher water absorption capability as well as better recyclability, strength and antibacterial properties will be developed. It is also possible that different bioactive functions and special filter or monitoring properties will be integrated with tissue products for different purposes such as diagnostic needs.

Countries with high populations and increasing living of standards, such as China and India, will have a growing demand for packaging and hygienic products in the near future. Packaging materials and tissue paper are typically the most profitable to produce near their end use because of high unit transportation costs. For example, tissue products are relatively expensive to transport and so they tend to be produced near the consuming markets. On the other hand, as carton board production for food packaging is typically based on coniferous virgin fibre that is available in the traditional producer regions of North America and western Europe, a significant part of production is likely to remain in Europe.

Along with the growing global interest in sustainability and recyclability, there will be a need to develop new material solutions, which offer many opportunities particularly for the wood and fibre industry. Today, replacing plastics by bio-plastics is very expensive, and without strong incentives from the operational environment it will not happen very fast. It is obvious that the price of crude oil will be the crucial long-term driver; however, there is a current need for effective policy intervention to promote faster introduction of sustainable materials. Also, materials used in intelligent packaging and printed electronics should not interfere with the disposal and recycling of the package – these issue needs to be taken into account as a potential barrier for wider market implementation.

Moving innovations successfully to the market

The FBS has set a strategy to become a major player in new bioeconomy products, such as advanced biofuels, intelligent packing and nanocellulose products, as well as in new building and living solutions for the construction sector, as stated in many strategy and research papers. While there are already many interesting products currently on the market, there is plenty of unutilized potential and room to introduce new products and businesses based on them. On the other hand, new investment are always a risk, and not all efforts are likely to succeed. A number of new wood-based products and materials are expected to appear on the market over the next 5–10 years. For instance, while commercial applications of nanocellulose are still in their infancy, potential applications seem to be extensive. The coming years will also likely see further advances in bio-composites, bio-plastics and regenerated cellulose fibres. There will be also new developments and applications in wood-based performance polymers (glues, resins and paints, etc.) and techno-chemicals (solvents, detergents and water chemicals). Areas of intensified R&D will also include energy industries, where new carriers for heating purposes and transportation are expected to be commercialized within a few years.

The FBS itself sees three main routes for innovation: 1) improve old products through incremental improvements; (2) develop radically new products; 3) or most likely do 1) and (2) simultaneously. Innovations in the wood-based products industry involve finding

products to replace existing materials; creating innovative applications for new lignocellulosic products; or using wood in new ways and with new concepts (prefabrication) in the construction sector.

Many conditions must be satisfied to encourage the successful diffusion of innovations. In general, technology as such cannot guarantee the success of an innovation if other aspects, such as environmental, political, economic, social, networking and institutional factors, related to the innovation are not accepted by stakeholders and customers. One critical issue in the FBS is that an integrated utilization of biomass and synergy returns will be needed to make the production of a wider array of products profitable. It also appears that in the past, the FBS has largely focused on technical innovations and development regarding productivity, whereas other issues, such as innovations needed for the diversification of business models and product portfolios, have been neglected.

In summary, the challenges related to new bio-based products and their implementation must not be seen as purely technical problems or as issues unconnected to society. In the following we introduce some of the key issues related to new products development and implementation that need to be carefully considered.

Implications for the forest-based sector

How will new products affect wood demand?

New forest-based products will impact wood raw material consumption and raw material markets. The demand for wood raw material depends both on production volume and the wood-intensity of the products. Many of the new products could be low-volume-high value-added products that do not require large raw material streams. Also, products, such as biofuels, could also be based on cascading use, i.e., side streams of the pulp and paper and wood products industries, or forest residues collected along with industrial roundwood. On the other hand, some of the products may also be large-volume bulk production, requiring a significant amount also 'new' forest biomass. In these cases and regions, increased competition for raw material may be expected.

In the chemicals industry, the large-scale transition from petroleum to biomass as the primary raw material has not yet been realized, but with emerging technologies and additional incentives this could take place, which further increases the use of forest-based feedstock. Nevertheless, at the same time the structural changes in global and EU-forest products markets will probably result in a notably lower demand for forest biomass for some of the current forest products, as indicated in Chapter 2. Particularly, reduced graphics paper production (and pulp used for it) is likely to decreases the demand and competition of forest-based biomass. Depending on the net effect on forest biomass demand, the price impacts and therefore the profitability of the new product developments may be effected positively or negatively. Moreover, there are synergies between the different products and forest biomass streams. For example, many new developments, such as forest biorefineries, are planned to be integrated with existing pulp and paper mills and companies, or will be dependent on the side streams of production, and thus not expected to be economically attractive without the integration or collaboration with pulp and paper mills.

The geographical issues and location of new production facilities are also uncertain. It is possible that large-scale raw material intensive production will, to some extent, be located outside Europe, close to the fast growing raw material sources and large growing

markets. Within Europe, different regions may also have different competitive advantages in producing the new products, as is the case for the existing products. An other important aspect of the development is that sectors outside the traditional forest industry are entering the European FBS, such as energy and chemical companies as well as private investment groups. The sector is thus diversifying, which could have many-sided implications for its development. Given the importance of these issues, it surprising how little research there is on them, if at all. Clearly, there is strong need for new studies to shed light on these questions.

Environmental sustainability needs to stay in focus

As indicated above, environmental sustainability is an important driver for the development of new forest-based products. For example, biorefineries are believed to increase resource efficiency in the forest industry due to the utilization of pulp and paper production residues and side streams. Often, the use of wood is also considered environmentally sustainable, given its intrinsic status as a renewable natural resource. However, since using wood as a raw material is also seen as a threat from an environmental perspective, bio-based products cannot automatically be considered sustainable per se. Bioproducts and bioenergy are questioned with adverse issues related to raw material, land use as well as water and carbon footprints. In particular, large-scale harvesting for biofuel and energy production and the related impact on soil carbon stocks have aroused critics, given that bio-based fuels and products are commonly indicated as a way to mitigate GHG emissions. However, many new forest-based products are either high-value, low-volume products using little amounts of wood fibres, or they may be based on side streams (cascading use) or forest residues, which do not significantly increase the demand for biomass. Nonetheless, if the new products significantly increase forest biomass consumption in a region, environmental sustainability cannot be compromised otherwise the business concept is unlikely to be sustainable.

Diversification and partnering necessary

Developing new products, establishing new value chains and starting commercial-scale businesses with new concepts in the FBS requires an understanding of the new markets and customers, management of change, R&D and technical expertise. Diversifying a product portfolio and implementing new products also require sufficient financial resources. The manufacture of CLT modules (discussed earlier) also offers an example of strategic change, where a forest industry company has transformed its business model and moved along the wood products value chain to be close to the constructor instead of being a traditional sawmill. In these types of businesses, collaboration and partnerships that combine the right set of skills, innovations and knowledge are needed. Forest industry companies can obtain knowledge through buying patents, licences and other immaterial rights, or they can acquire or merge with other companies. This means that forest industry companies do not necessarily have to develop new technologies by themselves during restructuring. There will be interesting opportunities for partnerships in the interfaces of the forest industry as well as the chemical, textile and energy industries. For example, in a case of one already existing biorefinery, a cluster of industries - chemicals, energy and pharmaceuticals – is composing a facility that produces number of products, such as lignin, bioethanol, that use conifer wood as the raw material. Overall, it appears that the sectors will become more intertwined when new forest-based products are developed and produced in interfaces of different sectors. Also, one probable outcome of

this development is that the traditional forest industry will fragment into several segments that are specialized in variety of forest-based products.

New products can also offer new possibilities for small- and medium-sized companies to diversify their product portfolios. Business start-ups in the field are increasing, and in many regions these companies are desired to generate potential for developments by strengthening local labour markets, welfare as well as the national economy, among others. These kinds of local enterprises could increase domestic consumption even in the times of low economic growth. For instance, there are several small-scale wood products companies that are specialized in high-quality design furniture. Nevertheless, compared to the large companies, small- and medium-sized companies often have less resources to develop new products or diversify their business models. In particular, long-term development projects can be too risky for small companies as in the case of CLT module production - small companies could participate as subcontractors while larger companies are needed to manage the value chain and carry the risks. It is also very likely that the development of new products and businesses requires new start-up companies with innovative ideas and business models.

Regional competitiveness of the new forest-based sector

As regards to the development of new forest products and businesses, there are a number of different product mixes and business possibilities with many related investment opportunities, but also with associated risk factors. The viability of each specific product-business-mix depends on end markets (demand, supply, prices), substitute markets (e.g., oil, plastics), biomass markets as well as on global, national and regional policies. These may vary between and even within countries. Also, the policies to support new products development depend on what they target. For example, depending on the degree that the policy emphasizes climate change mitigation, domestic energy production, rural employment, energy efficiency, or some combination of these, the optimal biorefinery concept may differ. In short, there is no single solution for all countries or regions; rather, there are a large number of different concepts, raw material options, production processes, and output mixes each tailored to be optimal for the local conditions and objectives.

Moreover, globalization and the fragmentation of product value chains into bring new challenges and opportunities for the FBS. Key questions in this context are: Where will the strengths and competitiveness be based in the future? and Which tasks are crucial for the long-term success of forest-based activities in a certain company, region or country? From the perspective of traditionally dominating forest industry countries in North America and western Europe, it is interesting to determine to what extent will large-scale manufacturing in the FBS be located to areas with an abundant supply of affordable biomass, low labour costs and rapidly growing markets. For example, it has been predicted that most biorefineries will eventually be located in South America and Asia, even if the pioneering mills are located in Scandinavia, western Europe and North America. Also, the emerging European economies (e.g. Poland and the Baltic Countries) may offer an attractive business environment for biorefineries in the near future due to relatively lower labour and other operational costs. Further, it is possible that due to decreased interest in developing lignocellulosic biofuels in the USA after recent deployment of new fossil reserves, Europe might gain a competitive advantage in developing

and commercializing new biofuel technologies. It is also important to consider the locations for smaller-scale novel production and new value-added tasks in the long term. This highlights the need for countries, sectors and organizations to carefully consider their future roles in the wood-based value chains and their long-term potential.

In the case that large-scale manufacturing of new products is mainly shifting to emerging economy countries, it also poses a challenge to maintaining R&D, innovation and knowledge base development in western Europe. It is important, therefore, to find a concept in the region to find core competencies and focus areas where competitiveness is maintained over the long term. In other words, regions also need to compete over the locations where companies set their activities in the global value chains. In the context of the development of new products, the role of local knowledge centres that combine know-how from diverse actors and sectors may play an increasing importance in the future. On the other hand, digitalization and distributed value chains enable individual companies that locate in various geographical areas to share their knowledge and to participate in global value chains.

It appears that activities carried out by high-skilled workers are increasing, whereas activities carried out by low- and medium-skilled workers are in decline. Today, robotics is a rapidly growing field as new technologies with automated machines that can replace humans in various tasks are being further developed. These technologies do not only take place in simple and mechanical jobs, but also in more highly-skilled tasks. Moreover, services – as part of a value chain – have become more important in the FBS (see Chapter 5); and as they are leading to changing educational requirements, more detailed analyses on future education and employment needs as well as the opportunities offered are necessary.

To date, research on new forest products has been very much technology-driven and specialized. This is natural, since advances in technology have been recent, and the possibilities for putting this technology into practice are only just opening up. However, now that the technology is close to the stage where it can be moved to commercial applications, there is a need for a synthesis of the current knowledge as well as analytical assessments of future environmental, economic and policy prospects. There is also clearly a need for further studies in this field. Research is also lacking on the socio-economic implications of the FBB on the forest sector as well as the environmental impacts.

Choosing policy instruments to promote new products

"It's not only the economy, stupid!" The arguments to twist this famous saying the other way round, as done here, seem justified when discussing the future development of the European FBS. Despite the global trend of market liberalization, politics will play an ever increasing role in the development of bioproducts and bioenergy markets. The European Union's emissions trading system (EU ETS), the 20-20-20 targets, and its update to 2030, are clear examples of this. Also, the EU's Bioeconomy Action Plan describes the Commission's main actions for the implementation of the Bioeconomy Strategy objectives and existing policy initiatives. The plan focuses on three key aspects: developing new technologies and processes for the bioeconomy; developing markets and competitiveness in bioeconomy sectors; and pushing policymakers and stakeholders to work more closely together.

The appearance of new forest-based products do not only bring different industrial sectors closer to each other, but also the variety of policy fields (e.g., forest policy, energy

policy, innovation policy, R&D policy, chemicals policy, etc.) become more intertwined. This means that there will also be a need for closer policy coordination between different policy fields to create optimal solutions for the implementation of new products.

The choice of specific policy instruments is a challenging task for many reasons; nevertheless, politicians are now in a situation where decisions need to be made based on inadequate and complex information as well as great uncertainty as regards to the future. Forest-based sectors cover a wide variety of products that can be produced from many different types of raw materials and with different technologies. At the same time, there are numerous developments on-going in the operating environment, which have important implications to the prospects of the new products. While identifying various influences may be possible, attaining an overall picture of the important influences and interactions in the fast changing environment, as well as identifying the specific competitive advantages of different European regions in this process is much more demanding. In addition to domestic and EU level policies, attention needs to be paid to international regulations, trade issues and regimes. Currently, there is lack of analysis and studies that would help to support strategy and policy-making in this respect.

It is obvious that the choice of specific policy instruments to support the European FBS to move to a new bioeconomy is a very important and challenging issue. For example, how can forest-based bioenergy development be promoted without damaging the opportunities for forest-based biomaterial (chemicals) development, or vice versa? Polices should be as neutral as possible and not distort the markets, yet there may be reasons to support a particular development. Policies can also have many indirect and hidden distorting impacts that should be identified beforehand. In the end, policy makers most likely need to be willing to priorities and accept trade-offs, meaning that an optimal solution from the perspective of all the stakeholders cannot always be achieved. Indeed, this is one important reason why policy makers have been chosen for their position.

It is often discussed whether to rely primarily on technology-neutral policy instruments (e.g. carbon taxes and/or emissions trading), or on technology-specific instruments (e.g. investment and R&D support for specific products). In the case of the former, the market forces mainly determine how the forest raw material should be allocated, whereas in the latter, the allocation would be more dependent on the policy-makers. Moreover, economists tend to argue that innovation and technology policies should focus on more general knowledge spillovers and more risky and longer-term issues, which the markets would not invest in without government support, rather than focus on one specific activity or activities that companies are likely to carry out even without support.

From the forest sector to bioeconomy

The European FBS is going through fundamental changes. FBS companies are diversifying their business models and product portfolios by developing new products and services based on forest biomass. Consequently, it appears that the traditional forest industry will break up into several segments that are specialized in a variety of products. Different industry sectors will become more intertwined when new forest-based products are produced at the interfaces of these sectors.

In future, forest biomass will be utilized for a variety of purposes and by many sectors; for this reason, it is no more valid to talk about the 'forest industry' or 'forest sector' in the traditional meaning. In fact, forest-based activities may be labelled under

bioeconomy in the future. This restructuring will cause major changes that will affect the whole FBS, including forest owners, individual companies and their business strategies, forestry professionals, education needs as well as policy priorities. When new products currently enter the markets on a commercial scale, it is important that these questions related to the transformation of the FBS, the implementation of new products and implications of this development are comprehensively addressed both by the decision makers and stakeholders. It should also be a priority area for new research.

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5.

Forest-based services outlook

Annukka Näyhä, Päivi Pelli and Lauri Hetemäki

Services of increasing importance

The service sector typically generates over 70% of GDP and of employment in many advanced economies. However, services contribute more than what is visible in the national accounts, employment figures or in the international trade statistics. Many manufacturing product value chains include a number of service-type tasks such as management, accounting, human resources, marketing, immaterial rights, branding, information systems, R&D, engineering and consulting services. Often, some of these tasks may be outsourced to joint ventures or external expert companies. For services growth, the development of digital communications and sensor technologies have been essential since they provide the platform through which services can be operated, managed and distributed. These technologies have also enabled the decentralization of the product value chains to tasks operated by many companies that can be located in different countries. As a result of this development, the services *tasks* trade has grown significantly, e.g. internal trade within multinational corporations. However, the share of services in world trade is significantly underestimated in trade statistics because of measurement problems. Currently, the OECD and World Trade Organization (WTO), for example, are working to provide more helpful statistics on services and trade in tasks.

The value chain and production process of many products are increasingly following a pattern, where the actual assembly or processing is carried out in emerging economies, but the more value-added services tasks, such as headquarter functions, R&D, patents, design, brand and marketing, are located in OECD countries. The business logic of how value is created and internationally distributed has changed, and at the same time is opening opportunities for new ways of doing business. The service-type activities play a crucial role in this development.

Figure 7 shows the 'smiling value chain curve', concept initially introduced by Stan Shih, the founder of Acer company. It is used to illustrate how the product value chain consists of many different tasks, some of which are 'services' and others 'assembly or 'production processes'. The smile also indicates that typically the services tasks are the most value-added parts of the value chain, whereas actual manufacturing typically generates low value-added. The tasks in the product value chain can be located geographically in many different places and produced by different companies. The smiling curve

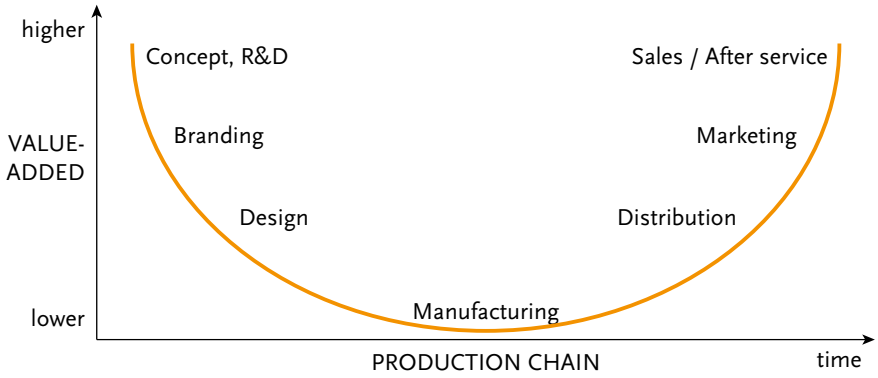

Figure 7. The smiling product value chain.

also highlights the fact that the division between 'manufacturing tasks' and 'services tasks' is very narrow and often difficult to distinguish from each other, and that they are both essential parts of a product value chain.

At the enterprise level, services are a part of new business models and crucial for strengthening the competitive advantage of a company. For example, many manufacturing companies in the machinery and engineering sector have extended their physical products with services. For example, KONE, an international lift manufacturer, is today gaining over half of its annual revenue from maintenance and other services. 'Servitizing', – adding to a tangible product intangible services and selling the function of a product in addition to the product itself – has evolved further into how companies carry out their business, innovate and create future markets. Some manufacturers have gradually moved totally to service activities, such as IBM from computers to consultancy, and to the development and implementation of complex information systems.

The forest-based sector is likely to follow the trend

There appears to be no reason why the forest-based sector (FBS) would not follow the above trend of servitizing. Moreover, the current trend in many major forest industry countries is to renew forest-based businesses, diversify products and increase added value. This trend seems to offer new opportunities and highlights the importance of services tasks in the future. Certainly, wood raw material will be sold for traditional forest industry production also in the future, as well as increasingly for new bioenergy products and biomaterials. However, it may be that more revenues and employment opportunities are created by services related to these products than actual manufacturing, assembly or production.

Services have been approached and studied from a variety of perspectives and is a many-sided field. Despite this, there is extensive literature on industry-related services in management and economics, whereas in the forest sciences literature, the concept of services has not been systematically investigated to date. In general, services have received little attention in the literature, even though services and related opportunities are already embedded throughout the forest-based value chains. Neither is the value creation potential of services in FBS fully recognized. Moreover, there are no studies that

provide an outlook for forest-based sector services, although there have been a number of outlook studies on forest products for many decades. In summary, it would be important to understand that the bioeconomy in future will also increasingly include services tasks, not only biomass-based manufacturing processes at the mill.

Classification of services in the forest-based sector

In order to illustrate the different role services play in the FBS, we classify them in three categories. *Forest-related services* refer to services that are directly attached to forests: nature tourism and recreation, hunting, mushroom and berry picking and other forest ecosystem services (i.e., non-wood goods and services) such as soil and water services and carbon sequestration. *Forestry-related services* refer to services that support the maintenance and development of forestry such as extension, forest management planning, forest inventory, administration, governance, research and development, and education. *Industry-related services* refer to services tasks linked to manufacturing processes and resulting products such as R&D, planning, communications, management, consulting, marketing, branding, sales and immaterial rights. By *industry* we refer to all industrial activities engaged in the production of forest-based products and include the current forest products and the new emerging bioenergy and biomaterial products that may be produced by the energy, chemical and food industries, among others.

In forest sciences, the major focus in services research has been in *forest-related services*, and in identifying non-market and non-wood ecosystem services and their valuation, as well as developing compensation and financing mechanisms for these services. Services, such as tourism and recreation, are recognized as important, but often only addressed on a limited scale due to the lack of data and information. Nonetheless, there are projections that show an increasing demand for recreation, nature tourism, health and wellbeing services due to an ageing population, growing environmental awareness and a rapidly increasing global middle-class in the emerging economies. For example, OECD projects the global middle-class to increase by about three billion from 2010–2030, which is also bound to impact nature tourism and recreation. However, in forest-related services' research, concrete examples and approaches of new service openings, analyses of their future business potentials as well as their impacts on the economy are for the most part lacking.

Services developments are also visible upstream from the production chain, i.e., forestry. *Forestry-related services* are often recognized as an expenditure, e.g. for managing forests, providing wood supply or developing forest ecosystem services and forests for multiple uses. They tend to be defined as extension services for forest owners, industry and administration, education and training, as well as research and development. Customer-orientation in forestry services for private forest owners means finding ways to support the forest owner's goals for his/her forests. Because the forest ownership is in many European countries fragmented and increasingly urbanized, there is a need for new kind of services tailored to benefit the changing forest ownership trends, and owners' new goals for their forests. At the same time, there is a global demand for expertise services in forest governance, forest administration, inventory and information systems, forestry education and R&D. Overall, the activities related to forestry are increasingly knowledge-intensive and address challenges such as those related to sustainability, assessing future recourse use and monitoring climate changes.

The *industry-related services tasks* have not only remained outside the scope of forest sciences, but are largely ignored by the new bioeconomy and industry strategies. The forest industry has traditionally sought competitiveness from large volumes (economies of scale), technology development and from resource efficiency. However, in many traditional forest industry countries, the services elements of the forest-based value chains are becoming increasingly important. Products such as wood-based modules (rooms) for multi-storey buildings, or smart packaging for food and pharmaceuticals, or hygiene products with diagnostic capabilities illustrate that the forest industry is already leaning downstream in the value chain towards the end customers, and often providing new services for them. In these examples, a forest industry company is not so much selling only 'a product', but rather a solution for the customer's needs. In effect, it is offering a bundle of wood-based (physical) products that are intertwined with services. The solution is customized to the customer's need and often already defined together with them. Moreover, satisfying the demand for FBS products requires not only material and technological know-how, but also new ways of building reputation and branding. For example, companies have to offer environmental and social sustainability, forest certification, FLEGT, no child labour, as well as recycling and resource-efficient solutions. In essence, the company needs to brand itself as a responsible partner with a good reputation. This is also an opportunity to provide new service-like activities, which help to increase the value creation and value capture of the product value chain. The services tasks can be produced by FBS companies, or in joint ventures between FBS and other companies, or they can be outsourced to external companies.

A lack of metrics and data on services

The international trade in tasks, e.g. transactions within large multinational enterprises across countries, makes it difficult to assess where and how value is created and captured. International trade statistics do not yet reveal this information. Recently, organizations, such as the World Trade Organization (WTO) and the OECD, have started work to compile statistics in order to capture the value of service tasks. Currently, however, the micro-level company- and product-level case studies have been the only means to try to quantitatively measure the significance of the value creation and trade in service tasks (e.g., iPad, mobile phones).

To illustrate the situation, we consider the value chains of two present FBS products that have very different types of value chains and service contents. In the case of two-by-four sawn timber in Finland, a traditional wood product, all the value stays in Finland when the raw material is sourced from domestic forests and is manufactured by Finnish sawmills. Around 50–55% of the value added is created by the timber and sawing with the share of logistics, wholesalers and retailers around 45–50%. On the other hand, for cross laminated timber (CLT) modules, a product that has been introduced to markets only recently, the value distribution looks very different. CLT modules are basically ready rooms that include electricity wiring, cables, thermal and acoustic insulation, windows and doors, all of which are assembled at the factory. The modules are then transported to building sites, and stacked like Lego blocks to form multi-storey buildings. The manufacturing of CLT modules includes a number of tasks that can be dispersed geographically by many companies that have different tasks in the product's value chain. Assembling the modules includes a number of tasks that are handled by different companies and

Box 1. Examples of forest-based sector services.

In order to illustrate the different types of forest-based sector services, we provide three abridged examples.

Case examples of three categories of FBS services.

Category of forest service	Forest-related	Forestry-related	Industry-related
	Nature tourism and recreation; hunting; mushroom and berry picking; soil and water services; carbon sequestration.	Extension; forest management planning; forest inventory; administration; governance; research and development; education; consulting.	Management; marketing; ICT; engineering; planning; design; branding; R&D; patents and licenses; consulting; customer training; maintenance.
Case examples	**Forest cooperative,** located in the boreal zone in northern Finland, offers nature tourism services; for example, renting of hunting lands, cabins, land and water areas in addition to traditional forestry and timber production. The cooperative expects that non-timber services will provide the most rapidly increasing income in the future.	**Forest information provider** offers information gathering system (GIS) solutions for forest inventory and natural resource management. The company has developed a service system that covers the collection, analysis and web-based dissemination of forest information. Future potential for services are found, e.g., in applications for sustainability assessments, forest conservation and eco-tourism purposes.	**Engineered wood products company** produces construction modules (rooms) for multi-storey wooden buildings. Modules are made of cross-laminated timber (CLT), and they include, e.g., electricity wiring, cables, thermal and acoustic insulation and other systems, which are all installed at the factory and then transferred to the construction site as ready-made room modules. The services tasks create most of the value added in the product value chain

The above three categories of FBS services can also overlap to some extent; for example, forestry services are closely linked to industry-related services or to the provision of nature-based tourism and recreation services. It is, nonetheless, useful to apply these three categories in order to highlight how the services relate to completely different types of FBS activities, and to raise attention to their role in the future development of the FBS.

experts. Overall, only a minor share of the value added and employment are related to raw material harvesting and processing, whereas the numerous services tasks create most of the value added in the CLT module value chain.

It appears that that the situation may be similar to that of CLT modules in terms of value creation and tasks for many new FBS products – many different services create most of the value added. Also, value creation is no more directly connected to production in one specific country; rather, the final product is built on several tangible and intangible assets combined in several locations across Europe or other regions. In these value networks, different countries or regions can find room for specialization; for example, on expertise on standards and other technical requirements, on engineering planning, on insights about the customers' needs and preferences, or on managing an efficient supplier network for multiple tasks in the production process. As a result of the dispersed tasks, a physical product does not necessarily need to trespass a country in order it to generate value added and employment in that country.

Figure 8. Fictional example of a product's value chain.

Outlook and implications

It is evident that the role of services in the FBS in Europe is increasing. This has many implications for the FBS, which have not been addressed in detail so far. Although it is difficult or even impossible to provide exact projections of this development and its implications, some of the major future trends that need to be analysed in this context are discussed below.

First, in response to increased digitalization or the so-called *Industrial Internet*, value chains can be disaggregated increasingly into different tasks, which may be located in different places geographically and carried out by different companies. This development is also breaking down the clear border between manufacturing and services. FBS companies need to create *new business models and strategies* that take into account the fast changing operating environment and fulfill the new demands. Production systems will evolve due to new developments and prospects related to sensor technology, nanotechnology and biotechnology, among others. The end-product will often be a bundle of products and services combined from the inputs of multiple suppliers across several sectors. Services and high value-added related tasks will increase, which means that new skills and capacities are needed. *Knowledge-intensive business services (KIBS)* can act a crucial facilitators and carrier of innovation. These services may be linked to specific know-how, such as forest certification, life-cycle analysis and the different labelling of forest-based products, or logistics, maintenance, branding and marketing, technical design and consulting services.

Increasing service intensity also offers new possibilities for start-up companies, small and medium-sized enterprises as well as new global micro-enterprises operating in

internationally distributed digital networks. There are also many inter-linkages and collaborative activities between different value chain actors. Therefore, new possibilities do not only span to the customers of forest-based value chains, but also extend to other natural resources sectors as well as sectors outside the natural resources sectors such as the chemical, energy, food, textiles and cosmetics industries. The orchestration of these value chains and the recognition of new opportunities to utilize forest-based materials requires emphasis on services tasks in the FBS.

Regional differences in competitive advantages in Europe

Trade in tasks is an opportunity and challenge for Europe. For example, to what extent will large volume FBS production move to emerging economies and what remains in Europe? How are the various tasks in the international production value chains divided and how can competitiveness be ensured in Europe in the global high value-added services tasks markets? Can Europe increase its skills and knowledge base to become a leader in these tasks in the FBS value chains? If this was to happen, it could very well be that employment and income in Europe are increasingly generated by R&D, education, consulting and knowledge-intensive services such as legal counselling, financing, branding, intellectual property rights, or for instance, management and monitoring of the complex production and distribution networks related to global forest industry. These questions are not only of interest to the FBS itself, but also to other interlinked sectors and stakeholders in society. In turn, these have implications on forest policy and governance issues as well as sustainability regulations, among others.

Services are not competing for employment with the manufacturing industry in Europe. On the contrary, services are an integral part of ensuring the competitiveness of manufacturing. This inter-linkage is illustrated by the evolution of employment in the manufacturing sector. In the machinery and engineering sector, for example, new types of employment in proactive maintenance, monitoring and servicing are emerging. They are based on harnessing the extensive 'big data' available for design, monitoring, production and marketing, and engineering as well as on implementing new solutions together with the customer.

The key issue for the European FBS is to understand and analyse the significance of the increasing servitizing of the sector. This focus is still clearly lacking, and its development has not yet been fully recognized within the European FBS. Nevertheless, it is likely to have significant impacts, for example, on a country's competitive advantages, FBS value creation, business strategies and models, and to the requirements for R&D, skills and employment. Moreover, it is important to discuss what role the global, national or sectorial policies have in the development and implementation of services based businesses. Should the policy strategies change to meet the changing focus of the FBS in the future? For example, the bioeconomy strategies tend to ignore the services issues raised in this chapter.

If the services are addressed in the FBS, the focus is typically narrow, often addressing forest-related services like tourism and recreation, or forestry-related support activities such as forest owner extension services. However, for the European FBS it would be very important to understand and analyse the significance of the increasing servitizing of the sector in order to fully benefit from new business opportunities that this development offers.

Currently, the focus in the FBS seems to be more in the present value chains and the technological development of new bioeconomy products. Less attention is being paid to the aspects of new value chains, trade in tasks, or the development of new service businesses related to industry, forestry, forest-related tourism, recreation and health services, among others. If the development in the FBS follows the trend observed in other manufacturing and processing sectors, it would imply that less of the physical production processes and assembly work will be carried out in western European countries with high labour costs and more in emerging economies and lower-cost European countries. For instance, many paper companies have invested increasingly to Asia and South America while furniture companies have already relocated their production to eastern Europe. As a result, some western European countries may be more focused on the services tasks related to the product value chains, or other FBS services, whereas others will be the manufactures of the actual products. This would naturally have an impact on forest utilization and industrial roundwood production in different countries. When providing the future outlook for the European forest-based sector, this type of trends should also be analysed and taken into account. There is also a clear need for an outlook study analysing the possible future of the European forest-based sector services.

Recommended reading

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6.

European regional outlook

6.1 Introduction

Lauri Hetemäki

The European continent is big enough to have wide differences in terms of how forested the areas are and the type of forests (e.g. boreal, temperate). The culture, economic significance and utilization of forests can also differ significantly. Consider Finland and the Netherlands, the most and the least forested continental countries in Europe. It is clear that the meaning of 'forest' for people in these countries differs to some extent. Thus, when we have so far discussed *the EU* or *European* forests, it masks a significant diversity across European countries, or even regions within the countries, in terms of forests and the importance of forest products.

Figure 9 presents a scatter plot of the European countries based on roundwood production and GDP per capita. It illustrates how relatively important forestry is for the country, when viewed against its economic wealth and population. It shows clear differences between countries. For example, Finland and Sweden, two densely forested countries, have high wood production and are wealthy. On the other hand, the Netherlands and Switzerland are very wealthy countries, but roundwood production is low. In Turkey, both the per capita income and roundwood production are low. Of course, this simple graph only reveals some simple facts, which could even lead to incorrect interpretations. For example, the roundwood production per capita in Germany and France are only about half of the European average, which would lead one to expect that their forest sectors are of low economic importance. However, if we look at the *absolute* values of annual roundwood production, for example, or the absolute value forest products exports (see Figure 10), Germany and France would be in the European top four with Finland and Sweden.

Both the relative and absolute values are important measures, but have somewhat different implications. First, if we categorise the European countries in terms of the relative *importance of the forest products sector* to a country's society and economy, we can divide them into three basic categories. The first group comprises countries for whom forest products play a very important economic role. These countries (shown in Figure 10) are clearly above the red linear regression ('average') line (namely, Finland, Sweden, Latvia and Estonia). To some extent, Norway can also be considered to belong to this group because of the characteristics of the forest sector in society. The fact that Norway's economy is dominated by the very strong energy and fisheries sectors separates it from the rest in this group. These countries tend to be characterized by many private forest owners and the forest industry has played important role in the country's development in

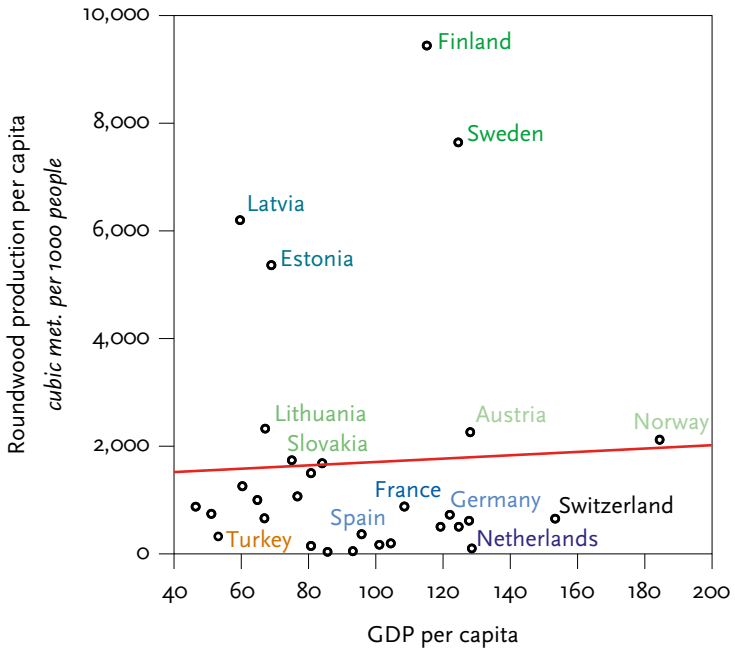

Figure 9. Classifying European countries according to roundwood production and economy. Data: FAOSTAT and IMF.

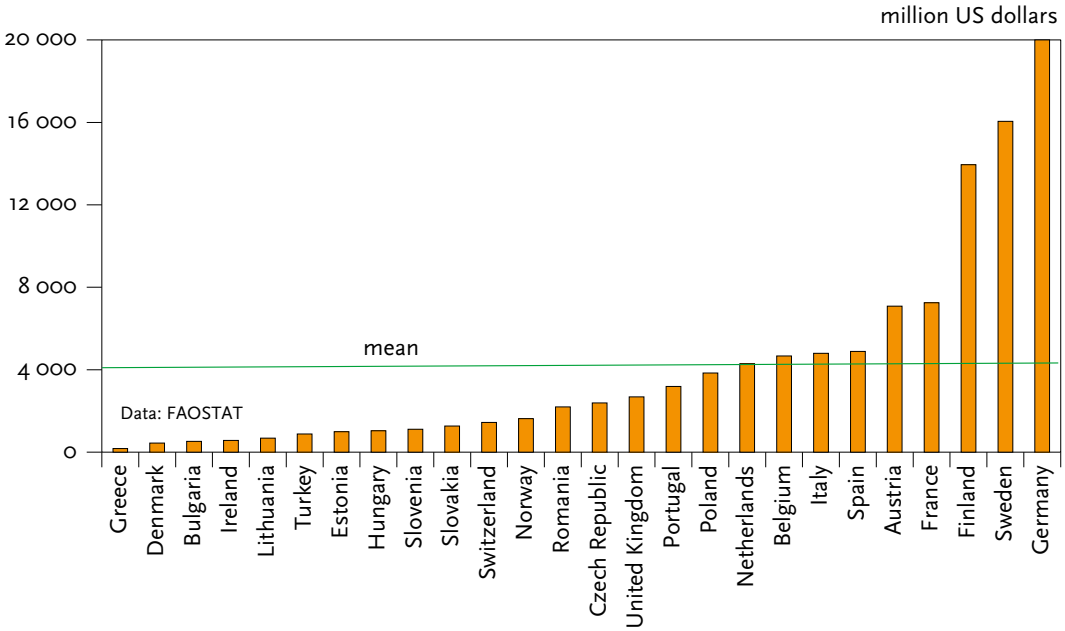

Figure 10. Forest products' export value in 2013.

the past century. Thus, these countries can be classified under the 'Northern European' region of the European forest-based sector.

Austria has a large forest industry sector, which plays a relatively major role in the economy. In some sense, it could be classified in the Northern European region due to the many similarities its forest products sector plays in society. However, due to its

geographical location and cultural characteristics, it is also close to the German and Swiss forest sectors, which are categorized as the 'Central European' region – the second group.

In terms of the value of forest products' exports (Figure 10), Spain and Portugal can be considered 'average' in Europe, but in terms of roundwood production per capita they are lower than 'average'. The forest sectors in Spain, Portugal and southern parts of France are characterized by fast growing eucalyptus plantations as well as serious forest fires, which add to its regional features and how the forest sector is viewed by society. These countries can be classified under the 'Southern European' region of the European forest sector – the third group.

There are number of countries and regions that do not fit well to any of the above classifications such as Turkey. However, we hope to illustrate at least some of the differences within Europe by utilizing the above classifications. Next, we turn to analyse these regional characteristics and issues at more detail.

6.2

Central-European outlook

Peter Schwarzbauer, Tobias Stern and Frederike Ettwein

Current state and recent trends

The forest-based sector in Central Europe (CE)[1] has many similarities to other forest-based sectors across Europe, but also differs in some aspects. Because these differences present both opportunities as well as barriers for future development, several important features of this sector are briefly discussed below. In general, the relative economic contribution of the forest-based sector to GDP in CE has so far been higher than in Southern Europe, but lower than in the Nordic countries.

With regard to forest area, CE has the highest growing stock worldwide – an average of 340 m^3/ha, compared to 140 m^3/ha in the Nordic countries and 170 m^3/ha in Europe as a whole. Also, the annual increment of 10 m^3/ha is almost double the European average. Thus, CE has a high forest resource potential, which allows intense, small-scale, economically feasible yet still sustainable forest management. On the other hand, due to the mountainous areas of the Alps, timber harvesting in many areas is more costly than in the Nordic countries (lower harvesting costs per m^3), for example, which favours the production of large diameter trees and assortments. In CE, therefore, the share of sawlogs in total roundwood production is higher while the share of pulpwood is much lower than in other parts of Europe. Although this situation seems to be a general advantage for the sawmill industry, it also constitutes an important limitation: modern technology for large sawmills (chipper canter technology) requires logs of smaller diameter, the supply of which is limited in CE.

Compared to North America and the Nordic countries, the cohesion and integration level of forestry into forest-based industries is very low to non-existant in CE. Forest owners – a large share of whom are small, non-industrial private owners (NIPF) – and industry sometimes view themselves as different branches, rather than one (forest-based sector). Nevertheless, it is claimed that they 'sit in the same boat' due to the shared raw material – wood. Improving logistics in the wood supply chain is thus a challenge.

Despite this, the availability of raw material resources, high technology know-how, strong tradition-based entrepreneurship and its position close to important markets (relatively low transportation costs) have so far contributed to the success of the CE forest-based industries. Unlike the situation in Europe as a whole, the production growth of all three major semi-finished products (sawnwood, wood-based panels, paper and paperboard) have generally been above GDP growth in CE for decades. In Austria and Germany, exports of forest products have increased more than domestic consumption

1 In Central Europe, we focus on the region covering Austria, Germany and Switzerland.

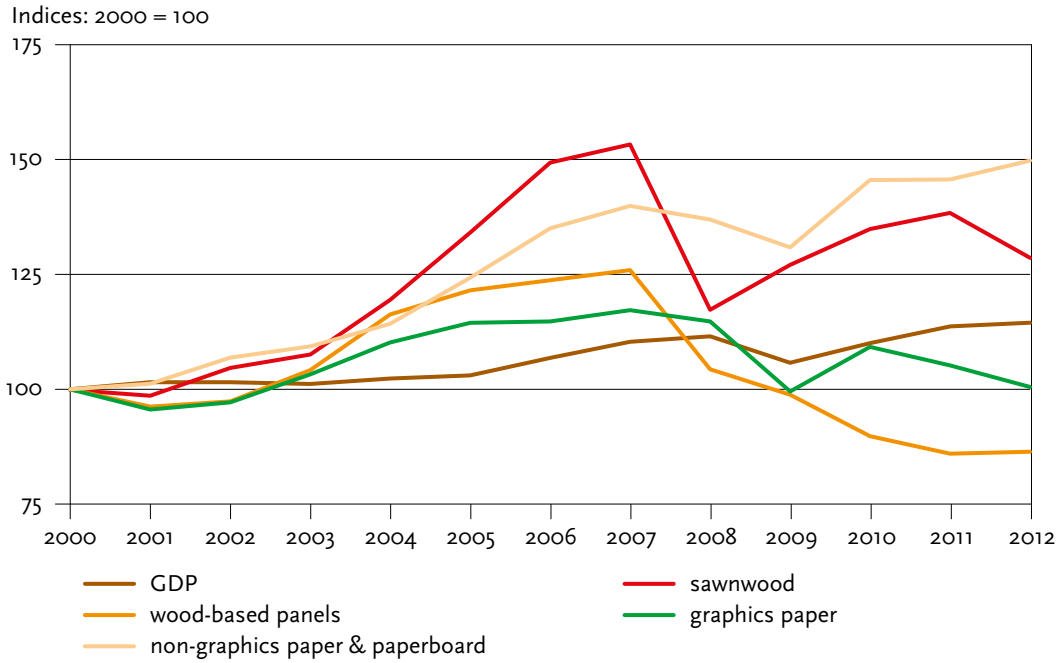

Figure 11. Forest products production in Germany and real GDP in 2000–2012.

since 1990; Germany has even turned from a net-importer of sawnwood, wood-based panels and paper into a net-exporter. However, production trends have become more diverse since (and even before) the recent economic crisis. In the case of sawnwood and non-graphics paper and paperboard, the economic crisis was not so severe; however, it resulted in the need for more structural changes in the case of wood-based panels and graphics paper (Figure 11).

While CE has been and is strong in the production of semi-finished forest products, it is less competitive in some end-use sectors such as construction and furniture. One explanation is the building tradition in CE. Compared to the Nordic countries, the share of wood and wood products in construction is much lower. However, wooden construction based on pre-fabricated engineered wood products has significantly increased. CE has never been a major furniture producer region in Europe. For furniture production, the proximity of forest resource is less important than other factors such as design (example Italy). The decline in the CE furniture industry since the economic crisis has affected the panel industry, in particular. The downturn of graphic paper is, of course, mainly caused by the evolving digital media, and not related to CE in particular.

Although many smaller wood processing units have been closed in CE, total capacities have remained at a high level, or even increased, which can be seen as a 'rebound effect'.[2] Total combined paper and paperboard production in Germany and Austria remained stable between 2007-2013, but declined in Switzerland by 29%. However, for

2 A 'rebound effect' refers to a phenomenon where behavioural or other systemic responses on a certain development (e.g. the introduction of new technologies) contradict the effects of the initial development, and therefore reduce the expected effects. The rebound effect has been mainly related to an increase in the efficiency of resource use, followed by an increase in general consumption.

graphic paper production there has been a decline between 8 to 50%, depdending on the country (Austria -8%, Germany -17%, and Swizerland -50%). In the wood products sector, sawnwood production has declined in Austria (-25%), Germany (-14%) and Swizerland (-28%) during 2007–2013. Wood-panels production declined in Germany by 5 million m^3 with no major changes in Austria and Switzerland.

Sawmills in Austria and Germany explicitly state excess capacity in this sector as a challenge. In the past, capacity expansion was based on a healthy demand in domestic and foreign markets, and significantly increasing imports of roundwood from neigbboring countries. For example, Austria imported 7.3 million m^3 industrial roundwood in 2012 – the second largest importer after China. About one third of industrial roundwood consumption in the Austrian sawmill and paper industry and one quarter in the wood-based panel industry is currently imported. A restructuring of the forest-based sector in CE is expected during the next decades, most likely focusing on diversification, given the political ambitions to support the development of a bioeconomy.

Review on CE outlook studies

During 2004–2014, many studies focusing on forest-based sector in CE were published (28 reviewed for this article). Some predictions raised in these studies are already taking place, while others have not done to date. A third category of developments relates to issues or trends that are now identifiable, but were not projected by the studies.

What was projected and what has materialized?

The majority of studies projected increasing roundwood prices from 2007 onwards, and a supply shortage of industrial roundwood in CE in the future. Because product prices have been increasing less than wood raw material prices (and other costs, such as labour and energy), forest-based industries' profits were expected to decline, or even become negative. The rising roundwood prices have been a positive development for the forest owners, as long as this trend does not force the industries to shut-down or move away.

Several studies present reasons for the shortage of supplies of roundwood. For example, due to demographic and sociological changes, there is, and will be in the future, an increase of urban forest owners and fragmented private forest ownerships in CE. For various reasons, these forest owners are expected to become less interested in forest management, and would thus require additional mobilization measures which, in turn, would increase procurement costs. Although this development has so far been largely compensated by higher actual harvests of the remaining NIPFs, the growing number of forest owners who are inactive in forest management would lead to declining timber supplies.

Another important aspect for CE is an increasing demand for nature conservation, which may lead to a competition for land-use and thus a decrease of potential roundwood supply. The discussion to set aside forest areas currently available for wood supply for conservation purposes is also an emotionally charged issue, especially in Germany. Some studies state conservation as one of the main reasons for the predicted decline in supply, while others claim that there is not, and will not, be direct competition between conservation and forestry. Whichever view prevails, nature conservation and biodiversity issues will most likely play an increasingly important role in the future.

One important aspect as regards future roundwood supply in CE is the dependency on and the availability of imports. About half of CE's industrial roundwood imports

have come from Eastern Europe. Since these countries are increasing their own forest-based industry capacity, as well as using wood more for bioenergy purposes, the imports to CE could decline in the future. In the case of Austria, sawlog imports have already significantly decreased. Also, with respect to the future roundwood imports from Russia, there are many uncertainties, not least because they tend to be impacted by political considerations in the country.

In addition, CE has a competitive disadvantage in long-distance transportation due to its limited access to seaways. Although some studies envisage a solution for this problem through more efficient logistics systems, transportation costs can be seen as major challenge both today and in the future. This being said, the main markets for CE countries tend to be in CE and the Western European region where CE industry has a clear advantage in terms of lower transportation costs, e.g. compared to the Nordic countries. Hence, transportation costs can be seen as a competitive advantage or disadvantage for CE industry, depending on where the markets are located. As a consequence of renewable energy and climate policies, forest biomass-based energy production has experienced a revival. This issue was analysed by all studies reviewed, which illustrates its importance. The studies also agree that the demand for woody biomass for energy will be even higher in the future, and grow faster than the demand for forest products. Some observers question whether there will be enough raw materials to meet this demand in CE, and highlight the potential lack of economic efficiency or ecologic sustainability.

The forest industry consolidation process has been on-going in the forest-based sector in CE for some time, and it will most likely continue in the future. Many investments made during the last decades focused on additional capacities and increasing the economies of scale as well as more efficient process technologies. However, there have been fewer significant investments in recent years as the mills are not operating at their full capacity due to the lack of financial resources in times of economic crisis; and because of the availability of low-cost existing capacities, some companies are going bankrupt. Moreover, the 'U-shaped' company size evolution has gained more importance due to the consolidation process, which tends to increase large companies, and due to the survival of the small companies that typically specialize in niche markets. As a result, middle size companies tend to disappear. In this context, several business strategies typically associated with consolidation processes are expected to continue in the future such as diversification, forward integration, outsourcing and technology leadership and supply.

What was projected and did not yet happen, but could still happen?

Regarding future demand, the image of wood plays a crucial role. Opinions on this subject differ considerably. Some studies cite wood as a material that has a major image problem: it does not reach consumers and fabricators, and it never communicates or receives the attention that could be associated with its positive potential as a raw material. The forest-based sector in CE is often considered as being backward-looking and too traditional. Other studies note that wood has a positive image with customers. Improving the societal perceptions of the forest-based sector and its products towards a sustainable society is one important challenge for the future. However, while the effects of this trend on the forest-based sector in CE have been overrated in the past, it could still have an increasing impact in the years to come.

The UNECE/FAO EFSOS II study reflects the possible future decline and/or stagnation of production and demand of sawnwood in CE, thus signalling a structural break

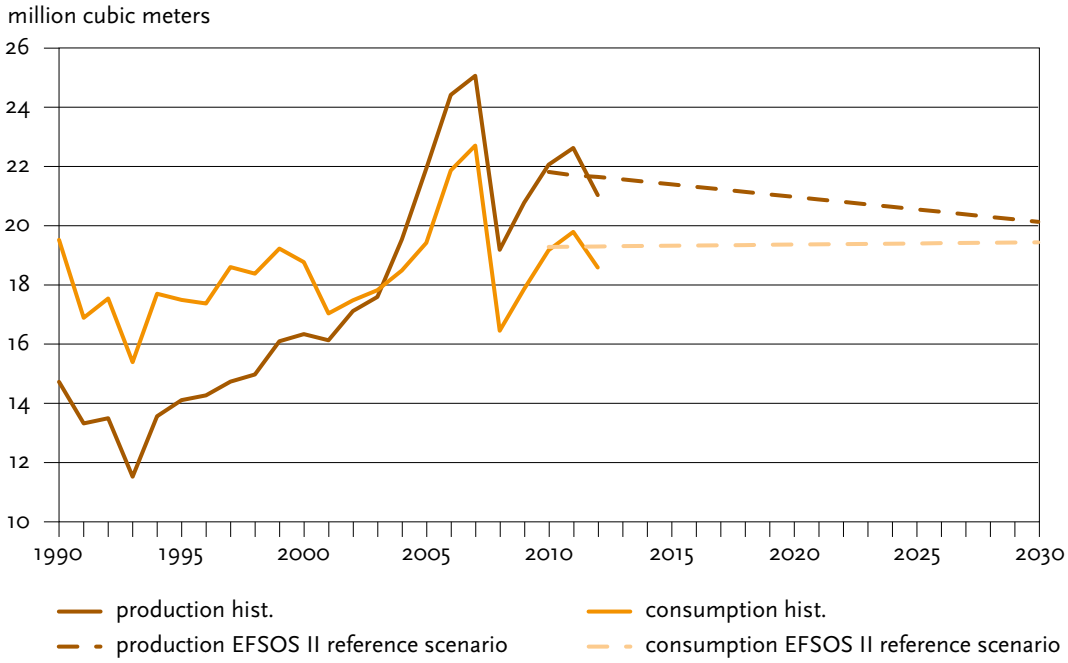

Figure 12. Production and consumption of sawnwood in Germany 1990–2012, and EFSOS II projections for 2010–2030.

as compared to the developments in the decades before (Figure 12). Although production and consumption of wood-based panels and paper and paperboard are projected to grow less in the future than in the past, growth is still assumed in this study.[3]

As stated in a number of the reviewed studies, the future demand for graphic paper will significantly decrease because digital media is replacing the demand for graphics papers. The development of the packaging industry is projected to be different, although a significant part of industrial goods manufacturing has moved to emerging economies and Eastern Europe. Unlike in North America and Western Europe as a whole, the production of packaging paper and paperboard is still assumed to moderately grow in CE, but at a slower rate than during 2000–2005. Also, regional products will most likely need regional packaging in the future. In total, Declining demand is thus on the horizon for the pulp and paper sector in CE, which can only be partly compensated by new export markets, for example, in Eastern Europe. However, some studies claim that the pulp and paper industry has still potential to maintain competitiveness by increasing its efficiency through energy savings, for example.

The above developments highlight the need for CE's forest industry to renew itself and seek new product opportunities. In this development, the emerging biorefineries are expected to play an important role also in CE (see Chapter 4). Most of the reviewed studies named biorefinery as one important strategy for the future.

3 The limitation of the EFSOS II study is that the behavior of producers and consumers is kept constant throughout the projection period (e.g. constant prices and income elasticities). Thus, the study cannot reflect any behavioral change in the future.

In this context, post-consumer wood and residuals from forestry and forest-based industries also form an important raw material basis. In addition, it has been stressed that the use of post-consumer wood provides a cradle-to-cradle production process, and increases resource and environmental efficiency. Recycling post-consumer wood and using it in the production process of wood-products, as is already done in particle board production, would prolong carbon storage before the final stage of the product's life cycle, i.e., using it for energy. This type of cascading use of forest biomass is expected to gain importance in the future, although it has not yet received full attention in practice to date.

Thinning material and landscape-care wood are also most likely to continue to gain importance. However, the competition for raw material, especially between particle board and energy production, will increase. Also, there are ecological aspects that have to be considered. Intensified stump extraction, for example, could have negative impacts on biodiversity, and is therefore currently not considered in CE countries.

Some studies predict a shift in tree species towards deciduous species in CE. The forest-based industry in CE has to face this development with new concepts for using other species (e.g. using hardwoods in construction). In addition, climate change will most likely increase the vulnerability and disturbances in forest ecosystems in the future and thus increase the already high share of timber harvests in CE due to damages (storms, pathogenes, etc.).

Another issue having important implications for the CE forest-based sector is the increasing role of Asia and South America in forest products production, especially China (see Chapter 2). In Austria and Germany, wood pulp imports grew faster than production during the last decade, indicating an increasing loss of competition in this product category. On the other hand, Asia is of high potential for CE as an export market. However, there is likely to be intensified competition between CE and Asia over raw material imports (e.g. from Russia), as well as the production of paper and paperboard and furniture, where CE so far has already faced tight competition. Nevertheless, it is expected that CE will remain a net-exporter with regard to wood-based products in the future.

Despite the increasing competition from the emerging economies, some studies also see some promising prospects for the CE furniture industry in the future. This view is based on the need for mass customized furniture focusing on regional needs and demands. This prospect is mentioned together with specialization and promoting of niche products. Finally, the building sector is seen as increasingly important for the CE wood products industry for a number of reasons. The building sector in Eastern Europe, in particular, could represent a new market if building with wood can be promoted successfully, and the export of prefabricated houses and wood construction elements make a breakthrough in the markets (see Chapters 2 and 4).

What was not projected at all?

Based on the above discussion, the following questions arises: Are there some issues that were not discussed in the reviewed studies, but which from today's, and the current authors' perspective, should be raised when considering the future of CE forest-based sector? What was not projected at all? In the following, a selection of relevant issues are discussed.

Wood scarcity as an innovation driver in CE

The issue of competition between different sectors using forest biomass needs perhaps more elaboration than was provided in the reviewed studies. For example, as a result of

the recent revisions made in renewable energy policies, the competition for wood raw material in CE could, at least to some extent, ease off. However, even in such a case, the overall availability is likely to remain tight due to other factors such as changes in NIPF structure, overcapacities in saw milling industries, the increasing demand of forest areas for conservation and declining imports. Therefore, the scarcity of wood could be one major driver affecting the future development of the forest-based sector in CE.

Scarcity is a fundamental economic driver behind the value of goods. Hence, a scenario of tight wood availability would also imply an increase in the value associated with wood. Apart from rising prices in wood markets, increasing scarcity could also increase the social and political perception of forests, forest management and roundwood, for example, which in recent years were not always considered as high value. Forest owners would be expected to profit directly under such development, whereas industries, especially when operating in global markets, would face increasing challenges to remain competitive. A major issue associated with this question is the structure of the demand served by a business. Serving regional demands at a higher cost may be less affected by raw material shortages than serving international markets, especially in applications that value domestic production. However, these trends are likely to trigger innovations that will shape the future of the forest-based sector in CE.

Most likely, an increasing scarcity will first of all lead to improvements in the supply chain management, as well as in the efficiency of forest management (more intensive in certain areas), and support the cascading use of wood. Furthermore, this driver could influence the structure of the industry by removing some capacities from the market to better adapt to the long-term available biomass supply. Current projections and sector expectations refer to certain declines, for instance in sawnwood and paper production, depending on the extent of the energy wood demand.

Many drivers may significantly influence the future forest products production capacity level in CE. For example, the profitability and international competitiveness of the specific industry sector will determine its capacity level (and roundwood demand), and the ability to pay for the raw material. However, overall profitability may give a misleading impression in some cases due to different strategic options of individual companies. Some companies, for example, may profit from shifting production units towards Eastern Europe or outside Europe. These companies can be expected to have lower barriers in giving up production facilities in CE. Other businesses are more or less related to local demand (e.g. energy, paperboard), which face much stronger exit barriers. Furthermore, the differences in a company's culture, such as family business versus a big multinational company, can favour or diminish exit barriers. Consequently, the industry structure could also change, if the role of small- and medium-scale companies increases and that of the larger companies decreases. On the other hand, if the U-shaped company size trend and increasing consolidation continues, it dis-favours middle-size companies and would thus provide an opposing trend. The net impacts on the company structure are thus not easy to predict.

A scarcity of raw materials can also trigger business strategies like backward or forward integration as well as diversification. For example, diversification in the utilization of raw materials can intensify the use of secondary raw materials (e.g. post-consumer wood, recycled paper), or biomass from non-forest areas (e.g. short rotation coppice, giant miscanthus, agricultural residues). In this context, a backward integration strategy, such as organizing material collection, would aim at getting control over parts of the required

raw material demand. In contrast, a forward integration strategy in this context would aim at shifting the business activity away from the increasing raw material costs towards more increased value added. However, all these strategies could also be accompanied by the emergence of new partnerships, possibly ones that involve new industrial sectors.

Competing goals, new entrants and shifting boundaries

The capacity development in CE's forest-based sector has both company-specific, as well as sub-sector specific drivers. As a consequence, it may be that a process of integration of different businesses is slowly replacing the old focus in economies of scale and concentration to one particular product. In the long term, this integration is likely to lead to completely new business models that will not fit in with the current sector's structure. In this context, three dilemmas for innovation and adoption, as described by recent research, will affect the forest-based sector in CE:

(1) the competing goals dilemma;
(2) the incumbent vs. new entrant competition dilemma;
(3) the industry boundaries dilemma.

The *competing goals dilemma* refers to the three dimensions of sustainability (economic, social and environmental), which are equally considered in the bioeconomic vision by the EU or CE governments, for example. It questions the potential trade-offs between the three dimensions and how they can be practically implemented. For instance, the 'food-fuel' debate is one outcome of this dilemma - the energy versus material debate is the equivalent on the forest-based side. Hence, aiming at all three sustainability objectives is a demanding task that will, in some cases, cause serious trade-offs and controversial public discussions.

The *incumbent vs. new entrant competition dilemma* is based on the fact that the vision of a new bioeconomy offers the opportunity for new entrants to successfully enter the biomass markets and replace the incumbents who have been the dominant players in the industry. For example, agricultural raw materials are becoming increasingly important for the health/pharmaceutical and chemical industries. In the case of the forest sector, while this dilemma is often related to new participants from the bioenergy market, it is definitely extending within the context of biorefinery development and also to other industry sectors (e.g. chemicals, food, textiles).

The third dilemma is connected to the redefinition of *industry boundaries*. Recently, industries such as telecommunications, information technologies and electronics, which were formerly distinct sectors, have largely faded. The vision of a bioeconomy is very likely to follow a comparable process; a process of convergence leads to 'new competitive landscapes', in which actors from different, formerly distinct industries, could become competitors or partners. For example, the distinction between forestry and agricultural production is becoming increasingly difficult. In contrast to agricultural-based biorefineries, forest biorefineries started by entering agricultural products markets (food additives) instead of petrochemicals. Value chains are becoming increasingly interlinked and interdependent, with new supply chains emerging that are both complex and with new industry players. This complexity is multiplied because of innovation systems that differ across industries. Hence, bioeconomy includes a strong aspect of cross-industry innovation that has been missing in the CE forest-based sector to date.

Glocalization business models

Glocalization, a combination of globalization and localization, is denoting the adaptation of the forest-based sector to the locality of CE. There are some indications that make glocalization a relevant development for the forest-based sector in CE. Promising in this context is the future possibility for locally (domestic) harvested wood products (HWP) to be credited for carbon sequestration within the Kyoto protocol agreement. While this development would be affected by a global trend (global climate policy), it would favour building with domestic wood and thus generate a positive local trend in CE. Taking into account the developments and conditions mentioned so far, this could lead to a domestic market pull by, for example, increasing wood buildings in urban areas. In addition, it would most likely help to develop CE as a centre of wood building technology (e.g. for Eastern Europe) considering local aspects (e.g. building traditions, architecture) in the sense of glocalization. This development would also favour the integration of construction businesses with a wood processing value chain, starting at chain-of-custody certification.

Glocalization could also favour smaller companies that focus on certain, especially local, market niches, similar to large diameter cutting sawmills in the past. There is already some indications of this process. Such a niche strategy has been chosen by companies that have stayed small in comparison to their competitors in the past. For some reasons, these companies have not abandoned the business or invested in a significant growth strategy. Niches can be defined by using certain raw materials, serving certain markets or customers, or producing very specific products. In the future, this trend would be expected to cover new product concepts and business models that focus on the value added along the entire value chain. In many cases, this will induce special requirements on raw materials (e.g. origin), and will define new and more integrated local value chains. Thus, glocalization offers an opportunity to what can be termed the 'emotionalization of the value chain'. The image of wood products and the communication within the complex stakeholder-system of the sector could gain more importance than it has previously done. Communication will focus on all dimensions and hierarchical levels of sustainability targeting issues of highly societal relevant meaning, such as:

- impacts of climate change on forests;
- climate policy including forests and wood products in carbon accounting;
- wood products substituting more resource and climate intensive materials (e.g. building with wood instead of other common building materials);
- uncertainty over user and producer acceptability of technologically new bio-based products;
- better understanding of the supply and demand of new bio-based products in the emerging bioeconomy;
- woody biomass becoming an important feedstock for biorefineries and energy production; and
- the increasing demand for wood, stressing the issue of mobilization from fragmented forest ownerships and sustainable harvesting.

Another important issue for the future development of the forest-based sector in CE is biorefineries. It is yet unknown what type of biorefinery concepts will successfully be implemented, and to what extend this will affect the forest-based sector in CE. This is

a key question defining the potential future dimension and scale of the industry, especially for the future of the CE's pulp and paper industry. At least the following are important for future biorefinery development:

- Does the environmental legislation favour the extension of existing industrial sites over building new ones?
- What is the position of related industries, such as the energy, chemical and food industries in CE biorefinery development?
- Will there be a need for a number of different concepts using different feedstock, but producing convergent platform chemicals?
- How will limited economies of scale - due to de-central feedstock generation and high transportation costs - influence the development (e.g. regional sites)?

Based on these considerations, it may be likely that a number of wood-based biorefineries will be established in CE and mostly integrated at existing mill sites. This development will secure a certain production level of the pulp and paper industry, but may also degrade paper as the (only) main product. New products, also from pulp, will change the production pattern of the industry and also introduce new stakeholders to the business. The target products may vary between each mill which would, due to diversification in demand, help stabilize wood demand in the long term.

Implications and strategies for policy and stakeholders

Summing up the developments discussed in this chapter, the following impacts on the forest-based sector in CE are expected to take place:

- A modest reduction of the growing stock in forests can be expected up to 2025. After decades of underutilization of the increasing growing stock, such a development would cause needs for changes in strategies and public communication.
- A shift in the age structure in forests towards younger stands could increase the average increment (a few per cent).
- Wood imports, especially for saw logs to, are expected to decrease.
- The importance of non-industrial private forest owners wood supply will increase.
- Rising roundwood prices in real terms can be expected.
- The overall economic performance of the sector (except forestry and sawmilling) will mainly depend on capacity cuts; once a significant reduction is reached, the economic situation is likely to improve significantly.
- Until this is achieved, the development of new product concepts and business models will be induced by the pressures of the market; however, the speed of development is likely to suffer from a lack of financial resources.
- In consequence, new players from other industrial sectors could enter forest-based businesses and take advantage of the under capitalization in the sector.

Based on these expectations and projections, it can be concluded that the issue of *resource efficiency* will be a key factor for the future development of the forest-based sector in CE. Activities at company level, such as business strategies, research and development, and improvements of resource efficiency at the sector level, are needed to address coordination and cooperation issues along the value chain. This would provide an exceptional

opportunity to overcome some historical gaps between stakeholders by improving the cohesion and integration level of forestry into forest-based industries in CE.

The forest-based sector in CE is considered a source of wealth and well-being for society, with an even greater potential for the future. Bioenergy, as well as bio-based products for building solutions and packaging applications will be increasingly supplemented by bio-chemicals, biofuels and bio-composites. The traditionally strong position of CE in technical research will be an excellent prerequisite in order for the sector to play a lead role in global development. Furthermore, the forest-based sector in CE is likely to be able to deliver these diversified products and service towards extensive markets nearby. Therefore, glocalization will be one strategy to secure competitive advantage in this context. Also, market orientation in sales and procurement, will be increasingly important when developing the technical solutions for these products and their processes. This development is likely to be supported by societal interest to move towards new bioeconomy.

The increasing number of stakeholders and their associated interests will be expressed by the *competing goals dilemma*. This is likely to be another political and social challenge for the traditional concept of multi-functionality associated with forest management in CE. When discussing different interests and goals associated with the forest-based sector and its resources, the societal perception of this process will be both a key challenge and a great opportunity. The challenge will be to create successful processes of communication in terms of channels, contents and target groups. Social media will provide the opportunity to transport the complexity of these issues, while reaching a large audience with limited financial resources, but still demanding expertise in selecting topics, language and presentation. Managing this challenge successfully offers the sector the opportunity to receive great societal recognition and support in the future.

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6.3

Northern-European outlook

Hans Fredrik Hoen and Lauri Hetemäki

In this chapter, 'Northern Europe' (NE) is understood as a *perspective*. The recent development, current state, structural changes and the outlook for development is analysed from the perspective of countries that have rich boreal forests, significant forest-based industries, significant bioenergy or bio-material potential based on forest biomass, and numerous private forest owners to whom forests generate income. Examples of such countries can be found among the Nordic and Baltic countries. We will not give a country-by-country overview, but rather present an overall analysis. When relevant and necessary, we will point to areas and issues where there are major differences in capacities, availability of resources and possibly also deviations in interests among major countries or regions: the Baltic countries, Finland, Norway and Sweden.

We focus on issues relevant to forest-based products and their markets, and how recent, ongoing and anticipated future changes will both challenge and provide new opportunities for the forest-based sector (FBS). Less emphasis is put on forest resources and the provision of raw material from the forests. This reflects the view that although the development of forests and supply of wood in NE is important, the major driving force in the sector comes from demand. Since all NE countries have small population size and domestic markets, their current and future forest-based sector is very much dependent on exports.

The major challenges within the NE forest-based industry cluster are a result of the structural changes in global and European forest products markets discussed in detail in Chapter 2. On the other hand, the major basis for future opportunities originate from the polices and market incentives related to transferring economies into low carbon bioeconomies.

In this Chapter, we first give a short overview of the state and prospects of the NE forest-based sector. Then we present the main results from some recent outlook studies of relevance for the FBS in NE. This is followed by a presentation of knowledge gaps – factors, issues and topics of importance for the sector's development which have not been addressed satisfactorily. Based on this, we provide comments and insights into the outlook for the FBS in NE. The chapter concludes with a discussion on the implications for decision makers and stakeholders.

The forest resource base – current state

The economic significance of forest sectors in NE are generally high, particularly in the Baltic countries, Finland and Sweden, where they account between 3–5% of the gross value added of the economies. This is two to four times more than in Europe on

average. Indeed, the NE region has a long history of processing different types of forest products, mainly for exports. Forest resources have been an important enabling factor for this to happen. NE is a forest-rich region, with roughly 1–4 hectares (ha) of forest and other wooded land per capita (the EU27 and world average is 0.35 and 0.73 ha/capita, respectively). Denmark and Iceland differ from other NE countries with significantly smaller forest resources.

According to Eurostat, the volume of timber in NE region constitutes about one third of the EU27 growing stock, which has increased by some 70% from the 1950 level in Finland, Norway and Sweden together. This is likely to continue as none of the countries have had removals (drain) above the annual increment for decades. Currently, Norway has a ratio of annual removals to an increment of 0.55, Finland 0.65, and Sweden 0.9. However, when discussing the forest resources in NE, it is important to consider that the region also utilizes to a significant amount Russia's (European part) vast timber resources for their forest industry.

In the NE region, a relatively high proportion of the forestland is privatively owned, between 60–85%, and the structure of ownership has been rather stable. In the long term, the production potential of NE forests depends on successful regeneration (investments) and silvicultural management practices aiming at the flexibility and robustness of forest ecosystems to adapt to environmental changes, for example climate change.

Recent trends for forest-based products and markets

The long-term prospects of forest industry production in NE have been seen as promising, such as in the UNECE/FAO European Forest Sector Outlook Study, or recently published global forest sector studies. These studies do not reveal any major changes – past trends are more or less projected to continue up to 2030. The biggest change is seen in increasing bioenergy production and related forest biomass demand. There is also some discussion on the prospects for new forest products, but at a rather general level.

However, some developments in the 21st century form a strong basis to expect that the future of FBS in NE is not likely to follow past trends to the extent projected by the above studies. The developments in global and European forest products markets have also important implications for NE forest industries (see Chapter 2). The structural changes in both the graphics paper and paperboard markets related to digital media, and the increasing role of emerging economies as paper and pulp producers are changing the prospects in NE. In addition, the long-lasting economic slump since the start of the financial crises in 2008 also seems to have some structural implications for the forest industry.

Figures 13a and b illustrate the impacts of these changes to forest products output in NE. Paper and paperboard production has declined by 20% from 2006 (the maximum level) to 2013. Sawnwood has declined by 17% from 2007 to 2013. Declining production has also been reflected in the decline in pulp and industrial roundwood production as shown in Figure 13b. The real prices for forest products have, on average, remained stable or declined. As a result, the forest industry's turnover and forest owners stumpage income have been declining. Partly, these trends have been offset by increasing productivity in the sector. However, the increase in productivity have implied typically declining employment in the sector.

The Finnish forest industry has experienced the largest production capacity shutdowns in the paper and wood products sector. In general terms, revenues, production

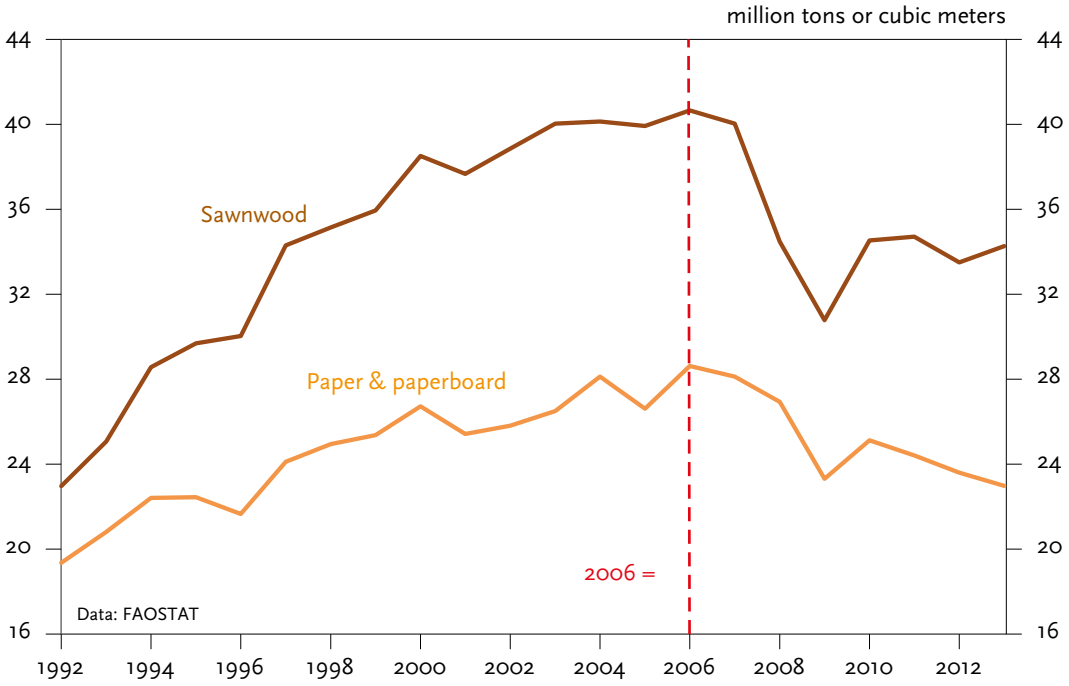

Figure 13a. Production of paper and paperboard and sawnwood in Estonia, Finland, Latvia, Lithuania, Norway and Sweden in 1992–2013.

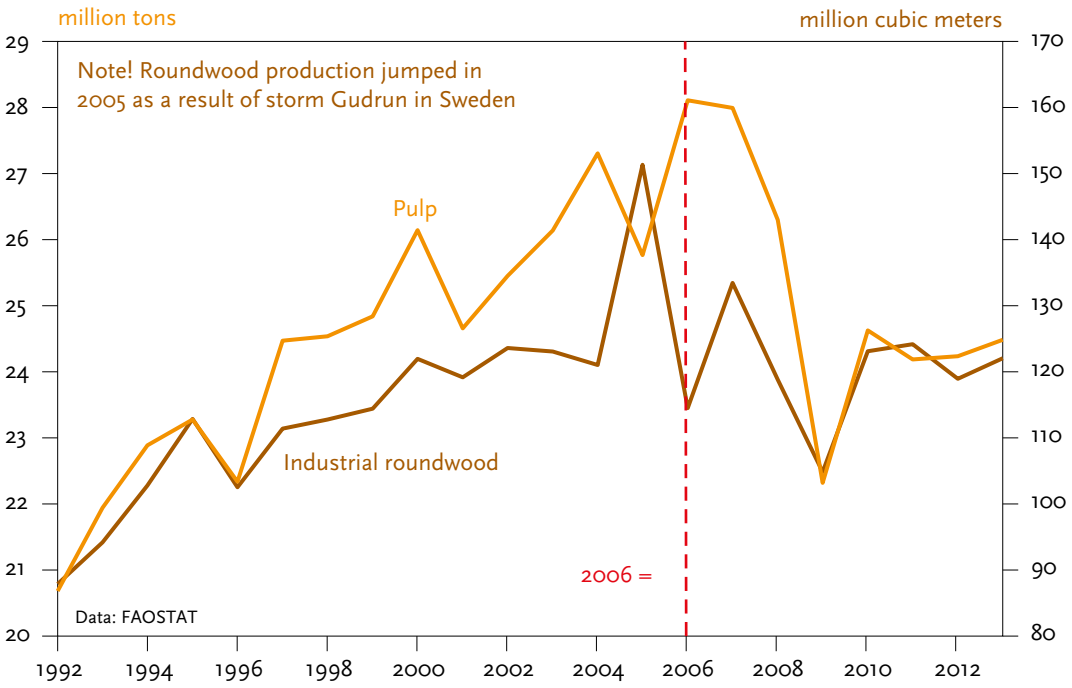

Figure 13b. Production of pulp and industrial roundwood in Estonia, Finland, Latvia, Lithuania, Norway and Sweden in 1992–2013.

and employment have declined roughly by one third during this century. Norway has experienced the biggest change in the paper sector - production has been declining since 2004, and in 2013 it was only about half of what it was a decade earlier. There has been no dramatic change in sawnwood, although production is slightly lower today than it has been on average over previous decades. For the Norwegian forest industry the past ten years has been a time of falling revenues, profit margins and investments. In Sweden, there has been stagnation and a slight decline in paper production in the past decade or so. From the all-time maximum production level of 12.1 million tonnes in 2006, production has declined to around 11 million tonnes and has remained at this level for the past five years. Sawnwood production had been steadily increasing up to 2007, when it was 18.7 million m^3. After this, the financial crises and slow economic growth in Europe caused production to fall continuously, and in 2013 it was 15% lower.

When analysing what the recent developments in the NE forest sector could imply for the longer-term future, the important question is: To what extent are the patterns shown in Figures 13 a and b due to economic slump, and to what extent they are structural patterns that will remain when the economic upturn eventually returns? Without further research it is difficult to say much more than the fact that both factors have influenced the development (see Chapter 2). The issue is also complex because the slump that began in 2007 has continued for seven years. This may start to have also structural impacts: the capacity shut downs initiated during the slump will not necessarily return at the same level when the upturn starts; or the industry's structure changes from low value-added products to high value-added products, such as from sawnwood to engineered wood products (EWP).

Fundamental changes in the industry

Unlike Figures 13a and b show for the past seven years, recent outlook-studies have estimated a continuous growth in NE paper and paperboard production and consumption, and project the growth to continue to 2030. Clearly, part of this 'over-projection' can be attributed to the fact that it was not able to take into account the long economic recession and slow economic growth in the main export markets. However, the fact that the decline started already before the economic slump in 2006, and that we observe similar trends in the North American paper sector, indicated that digital media and the increasing role of emerging economies as producers of forest products are also playing an important role in the developments in NE countries. This has also been the conclusion of several studies in the past years with some even projecting this to happen in the late 1990s.

Both Finland and Norway have concentrated production to communication papers, which is the product group most hard hit by structural change, i.e. substitution by digital media. Since 2005, Norway has experienced a series of paper and pulp mill shutdowns, which has resulted in a dramatic change also in the roundwood markets. According to FAOSTAT, Norway was still a major *net importer* of industrial roundwood in 2006 (2.6 million m^3), but since then has turned to a major *net exporter* (1.9 million m^3 in 2013).

The market development for packaging paper differs from the communication paper sector. The rapid growth in Internet trading is likely to increase packaging paper consumption. However, industrial products are increasingly being manufactured in emerging economies instead of OECD economies; accordingly, the packaging and packaging paper demand has moved increasingly to emerging economies. As a result, also

the production of packaging paper has been grown in emerging economies, even more than its consumption. This development has been reflected in slow growth or stagnating production in NE countries (declining in Norway).

In summary, we find it likely that the recent assessments, such as UN-ECE European Forest Sector Outlook study, do not capture the recent trends in NE countries, nor their future developments. Some of the research findings and consulting companies' detailed market outlook studies, such as RISI, also point to this conclusion.

These structural changes have also been acknowledged by companies in the forest industry. As a result, a number of companies, as well as governments in NE, have updated their strategies related to the forest-based sector. There are now significant efforts to renew the sector and embark on the road of developing new products and services that answer the needs of tomorrow's bio- or green economy. In this sense, the current structural changes have also been important in that they have redirected R&D and investment plans in the region. What does this mean in practice?

Emergence of new products and business concepts

The objective of the future bioeconomy in NE is to generate new economic growth and new jobs, while reducing environmental risks, securing ecological viability and the overall resilience of nature's ecosystems. Under this general objective, many of the NE countries seek to develop new forest-based businesses by stimulating research-based innovations as well as supporting the promotion and branding of new and emerging products and materials. In achieving these objectives, the countries seek to enhance and support cross-sectorial cooperation and to invest in research and development. These are seen as central enabling factors in the transition to the bioeconomy. Since this transformation has already been discussed in Chapters 2–4, here we will address issues that are specifically relevant for the NE region.

There is a long history of large pulp and paper industry companies, especially in Finland, Norway and Sweden, which have become increasingly multinational since about the 1990s. There are also a large number of SMEs the wood products sector. Given the strong role these companies play, it is expected that the new businesses will develop to a significant degree along the existing forest businesses. The transformation to new products and services in the coming decade(s) is likely to be financed to a major degree from the revenues of the current forest products. There are already, and will increasingly be in future, other operators utilizing forest biomass for products, such as the energy, chemicals and food industries as well as private investment groups. However, at least in the coming five to ten years, the current forest industry companies will most likely continue to play a major role in the process of transforming the sector to new products and services. For this reason, it will be important for their current activities to stay competitive and profitable.

Challenges and opportunities of the NE forest sector

The structural changes that are happening in the European forest sector seem to be even more striking in the NE region, where there has been heavy focus on the paper industry, especially the graphics paper industry (Finland and Norway). Some traditional forest

industry products are likely to stagnate or decline rather than increase. Notwithstanding, the renewal of the forest based sector is perhaps stronger in the NE region than anywhere else in Europe. In summary, some of the main challenges and opportunities for the FBS in NE will be the following:

- How can the forest businesses be successfully transformed and renewed during the next decade? How can the current businesses remain profitable while gradually launching new businesses at the same time?
- How can it respond to the increasing competition from the emerging economies and the Eastern European forest industry (e.g., China, South-America, Russia, Poland)? Possible options: Move to new, higher value-added products and services; enhance even more the approach to sustainability and branding to differentiate from its competitors; increase productivity.
- How can it cope with the graphics paper capacity? Possible options: Disinvest the graphics paper capacity; increase market shares in order to better control pricing. A status quo option is not likely to be successful in the long-run.
- To what extent will the NE region in the future be a raw material processor of forest biomass to new products, and to what extent will it be a service provider for these products? Where can we expect the competitive advantages of NE industries to be in the future?
- Services are considered to play a significant and growing role in the new bioeconomy value chains. Increasing the service-intensiveness of the products and immaterial value creation are clear trends that will open up new business opportunities, in particular for SMEs, and encourage cooperation and partnerships between companies.
- To promote bioeconomy competitiveness and growth, it is important to utilize regional specialization based on local/regional strengths and resources, as well as internal EU and global market opportunities. The idea of having large industry 'locomotives' networking with more specialized SMEs that produce niche products from side-streams from biorefinery or bioproduct mills, appears promising.
- There are many examples of promising plans and projects such as Metsä Group's bioproduct mill; the Borregaard Sarpsborg demo biorefinery; the Statkraft/Södra biodiesel planning project; UPM Lapeenranta's second generation biodiesel production from tall oil; and Stora Enso's engineered wood products for multi-storey buildings (CLT modules). This is not an exhaustive list - there are a large number of other interesting plans and projects that have been launched in recent years. In addition to the forest industry, private investment groups and energy companies have plans to produce heat, power and biofuels from forest biomass with new and more resource-efficient technologies, all of which appear promising.
- Increasing the added value of bio-based products and services, and their increased appeal to customers can be achieved by investing in brand management, intellectual property rights and design; at the same time, competitive advantages can be achieved, which are difficult to imitate.
- The forest based sector has been traditionally very much dominated by two industries in NE region: the pulp and paper industry, and the wood products industry. In the future, it will become much more diversified and less homogenous. This is likely to have many new implications. For example, new companies coming from the energy and chemicals industries as well as private investment companies, can bring much needed financing for the transformation of NE forest-based sectors.

- It is unlikely that the *biomass supply* is going to be the main bottleneck in many NE countries for the future development, at least until 2020. The more important factor is likely to be how the NE region manages to generate new competitive, and more value added products and services.

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6.4

South-Western European outlook

Inazio Martinez de Arano and Yves Lesgourgues

Background of south-western forests

This Chapter focuses on forest-based sectors in France, Portugal and Spain. The forest area represents 31% of the national surface in France (wood production app. 65 million m^3); and 35% in Portugal (13 million m^3); and 36% Spain (16 million m^3). Notably, Portugal is the only European country that has a net-loss of forest area in the last decade. This chapter will mainly focus on the south-western parts of these countries, paying attention only sporadically to other southern regions.

Two main forest regions can be distinguished in South-Western Europe (SWE), the plantation oriented Atlantic rim that borders the gulf of Biscay, and the low management Mediterranean forests that dominate most of central and southern Portugal, southern France and most of Spain and Italy. In general, Southern European forests are very diverse, not only in terms of biophysical and ecological conditions, but also in the cultural and economic contexts.

Atlantic forests

For historical reasons, the humid and temperate Atlantic forests are dominated by plantation forests with significant share of exotic species. Maritime pine and eucalyptus are the main species in this region, constituting of four million hectares of forested area. Mainly in northern Spain, also radiate pine and scotch pine are important. With average growth rates typically in the range of 10–20 m^3/ha, this relatively small region produces some 30 million cubic meters of roundwood. This includes over 75% of the Portuguese and Spanish wood production, and 34% of the total French softwood production. Harvest intensity is typically around 50–70% of the total growth, and is mainly based in plantations that provide over 95% of all wood produced. Management intensity and wood production is very low in the remaining semi-natural forests present in mountain areas.

The productive commercial forest plantations are mainly privately owned – as much as 90% in Portugal or Galicia. Average ownership size is very small; around one hectare in northern Portugal and western Spain, and up to six to nine hectares in the Basque Country and Aquitaine. Forest owners are quite elderly with new owners inheriting their forests typically at ages between 60 and 65 years old. As a consequence, this *generational change* is bringing new urban forest owners, but not necessarily younger ones.

Contrary to the situation in the Nordic countries, forest owner organisations are rather new and, with some exceptions, generally weak. Also, with the exception of France, forest cooperatives are mainly non-existent. Moreover, in contrast to some Central European regions, public forest owners do not play as active a role in wood production.

The predominance of fragmented, private and aging ownership, weak producer organisations, and sometimes a lack of infrastructure in rough terrains, results in major wood mobilisation difficulties. From the future development perspective, the worrying issue with this is that it also complicates information flows and the uptake of innovation.

Mediterranean forests

In contrast to the Atlantic region, most of the other south-western region of Europe is covered by low productivity and low management Mediterranean forests. These are characterised by a dryer climate, much lower productivity, high erosion risk and by very low management intensities which, in turn, are directly linked with rural abandonment and the low value of forest products.

Across the northern shore of the Mediterranean, forests are expanding rapidly due to the re-colonisation of abandoned rural lands. Only in Spain, forest has expanded four million hectares in the last 20 years. Catalonia, which harvests less than 15% of the forest growth, is thought to be reaching the highest forest cover in the last 1,000 years. In comparison, Italy harvests around 30% of the total growth.

Forest fires are a major and increasing concern in the south-western region. In fact, the expansions of forest is positively correlated with the increased frequency of large forest fires. These are a rather new phenomena in Southern Europe. The causes behind this trend are a combination of young forests that cover large, continuous areas, high fuel loads due to low management, and dry, hot and windy summers. The very high costs of fire combat are a key factor conditioning Mediterranean forest policy.

Some research, and also forest communities to a larger extent, indicate that the state of Mediterranean forests and the forest sector is suffering from the lack of markets for many forest-related ecosystem services (biodiversity, water, carbon, cultural heritage, etc.). This is because there are no markets for these valuable forest services and thus a lack of incentives to manage and take care of the forests. This, along with the forest ownership structure described above and the very weak forest owner organisations make it difficult to mobilise resources to invest in forestry. However, there are some locally very important niche value chains in the Mediterranean, notably linked to cork, pine nut or poplar wood production. Because of their specificity and very local nature, they are not discussed in this chapter.

This chapter focuses on analysing national trends, at which level there is also data. However, it should be kept in mind that regional differences are great within the countries. For example, Catalonia and Valencia have very limited wood production, but nevertheless are national leaders in the paper and wood working industries, as well as in roundwood imports.[1]

The current state of the forest-based sector

The forest-based sector in SWE is also affected by the global trends described in Chapters 1–5, such as globalisation, the displacement of forest product demand and manufacturing to the East, the emergence of new fibre producing countries in the South (Latin

1 Evidently, the situation in France is even more heterogeneous as it also shares many common features of the Central European forestry.

America). Also, with some regional differences, the trends in political momentum to move towards a low-carbon economy and the bioeconomy, the increased relevance of new societal demands in relation to land use and forest management are impacting SWE forest-based sector.

There are, however, clear differences in the capacity to adapt and to react to these global challenges. This depends very much on the internal structure of the forest-based sector, and the regional socio-economic environment. For example, some specific regional factors and incidents impact the possibilities of the SWE region to face the challenges and take the opportunities related to these global and policy changes, such as:

1) The economic downturn has been very deep and has affected the construction sector, in particular.
2) Cutting or terminating feed-in tariff regimes for renewable energies and biomass have halted developments in the region, especially affecting forest biomass based cogeneration and electricity production in Spain and Portugal.
3) The storm Klaus in 2009 felled 40 million m^3 of roundwood, mainly in south-west France and disrupted the markets already within a context of very weak demand; it also reduced the short and mid-term supply capacity of Aquitaine's forests[2].
4) The outbreak of the pine wilt nematode in Portugal has limited pine wood exports from the country and greatly affected internal markets. The potential expansion of this quarantine disease to Spain and other countries generates significant uncertainties for the future.
5) The high risk of forest fires. An average of approximately 240,000 hectares are consumed by forest fires every year in Spain and Portugal alone. Adding France, Italy and Greece this average rises to 400,000 hectares per year. Moreover, combating forest fires is costly and uses the biggest share of public forestry resources, which could perhaps otherwise be available for forest innovation support, for example.

When will the forest industry production recover?

Forest industry plays rather big role in Portugal's economy – representing 5% of GDP, 8% of the industrial GDP and 10% of total exports. Its weight in the national economy is much lower in France (3% of GDP), and in Spain (1.4% of GDP). France is a net exporter of roundwood, but a net importer of pulp, paper, and furniture products. Spain has also been a clear net importer of forest products, but this has been changing during the economic slump when imports have significantly been reduced (roundwood, paper, sawnwood) and exports increasing (roundwood).

Diverse development in the pulp and paper industry

The *pulp and paper* sector has some major domestic companies in SWE, but also multinational companies. The industry dominates and structures the forest-based sector in

2 The combined effects of the storms Martin-Lothar (1999) and Klaus (2009) reduced the stock of south-west France's coniferous forests from 190 million m3 to 90 million m3.

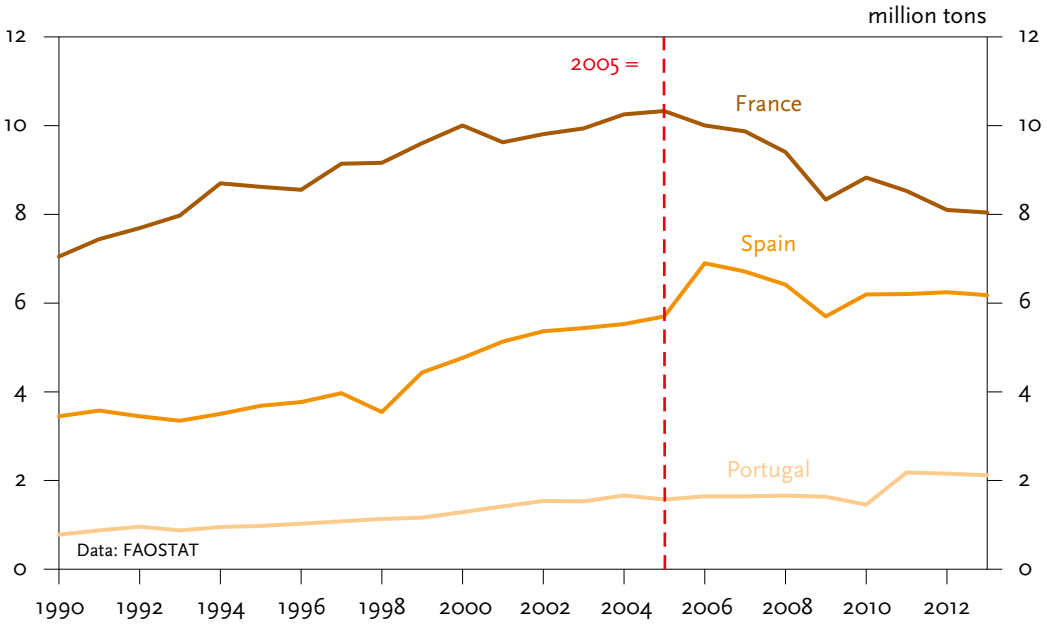

Figure 14. Paper and paperboard production in 1990–2013.

Spain and Portugal, and also plays a rather important role in south-west France. In recent years, however, the trend of the paper industry has been heterogeneous in these countries, as shown by Figure 14.

The French paper industry reached its historical maximum production level and turning point in 2005 with just over 10 million tonnes. Since then, it has been declining and is currently about one-fifth of the 2005 level. This trend is a result of the global developments and the decline in graphics (communication) paper consumption. Graphics paper production in France has decreased by 37% from 2005–2013, which is mainly explained by the decline in consumption (-32%). Paperboard and packaging production has declined by 14% from 2005–2013. Currently, there is no sign of recovery in paper production with capacity closures taking place during the last three years.

The development of French pulp production has been more diverse. Mechanical pulp production has been declining since 1995 and is now only about one-third of what it used to be. On the other hand, chemical pulp production was declining between 1997–2011, but in the past two years has recovered and is currently over two million tonnes. The pulp industry consumes roundwood equal to almost one-fifth of the annual French industrial roundwood harvests.

Interestingly, the situation in the pulp and paper sector is very different in Portugal and Spain than in France (see Figure 14). Paper and paperboard production has been increasing in Portugal despite the economic downturn, the challenge from digital media and emerging economies production. Remarkably, in Portugal graphic paper represents 72% of paper production (up from 63% in 2006), while packaging represents only 18% (down from 27% in 2006). This is in big contrast with France and many other Western European countries, where graphic paper is declining and the share of paperboard and packaging increasing. Also, in Portugal pulp production has increased by about 30% in the last decade (specially eucalyptus-based pulp), and was Europe's fifth

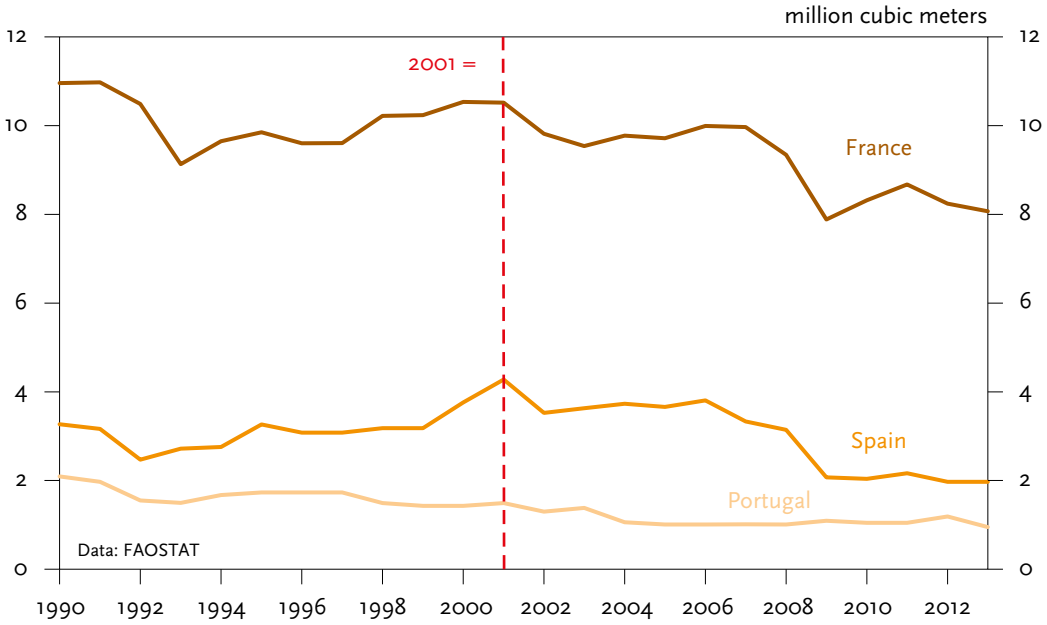

Figure 15. Sawnwood production in 1990–2013.

biggest producer in 2013 (2.5 million tonnes) according to FAOSTAT data. The Spanish pulp and paper industry seems to have stabilised its production levels after the decline in 2006–2010. The long-term trend has been positive and more resembles the Portuguese development than the French. Spanish paper production is mainly based on eucalyptus with the country's export markets representing more than half of the total production. Spanish pulp production has been around two million tonnes in recent decades and is rather stable despite the economic crises. Some of the key factors that help explain the better performance of the Iberian pulp and paper industry, compared to other Western European countries, are the large share of eucalyptus raw material, the focus on export markets and corporate strategies (e.g. strong paper brands of the Portuguese industry).

The wood products industry facing decline

Contrary to the pulp and paper sector, the SWE wood products industry is mainly based on family-owned SMSs with limited innovation capacity, a low presence in global markets, and to a large extent the bulk production of low value-added products. Higher added-value markets, such as furniture or engineered wood products, are dominated by imported timber.

During the last decade, the SWE *wood products industry* has suffered from increasing global competition and the long-lasting economic downturn. The sector is undergoing a structural change with many small mills disappearing in a process that started already before the economic downturn. Figure 15 shows the declining *sawnwood production* since 2001. From 2001–2013, sawnwood production declined in France by 23%; by 54% in Spain; and by 36% in Portugal. This trend has also been reflected in a significant number of jobs lost in the industry in SWE. The situation is also reflected, for example, in the number of sawmills in France, which has declined by 20% since 2005. The remaining mills are mainly still very small – the top 210 sawmills

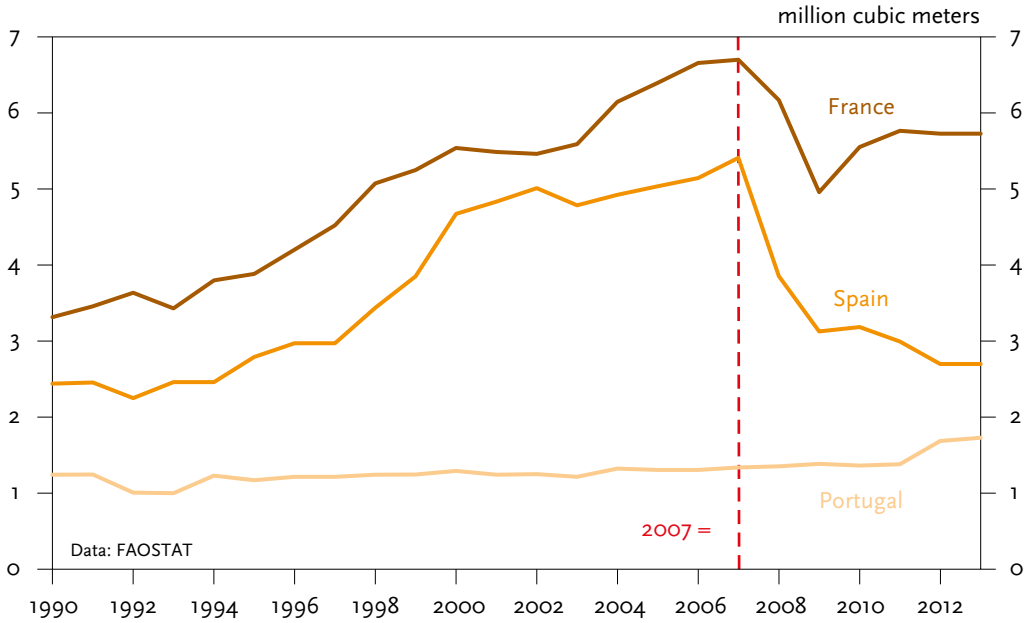

Figure 16. Wood panels production in 1990–2013.

producing 76% of all sawnwood have an average capacity of only 20,000m³/a, and only three mills produce over 100,000 m³/a. A further reduction of almost 30% of sawmills by 2020 is anticipated by forest industries. The situation is similar in Spain and Portugal. In addition to global competition and the economic downturn, Portuguese production has also been hit by wood products export restrictions due to the pine wilt nematode quarantine.

In Portugal, the pine wilt nematode quarantine is an additional factor affecting the present and future of the sawmill industry by negatively influencing exports. Partly as a result of this, there has been a strong move away from softwood plantations, which have only partially been compensated with an expansion of eucalyptus. This is clearly visible in the national forest inventory (maritime pine has lost 25% of its surface since 1995). Recently, chips exports are activating the softwood markets, but putting additional pressure on sawmills. This move away from softwoods is difficult to overcome in the mid-term; it also reduces the chance that the Portuguese sawmilling industry will recover. The presence of some isolated spots of pine wilt nematode along the border with Portugal signals the possibility that Spain could soon be facing a similar challenge. However, the potential impact to Spain and other countries will largely depend on the quarantine and accompanying measures that will be taken.

The development in the SWE *wood panel industry* has been somewhat different to the sawnwood industry. Wood panels production clearly continued to increase until the economic downturn started in 2008 (see Figure 16). However, the economic downturn caused a significant drop in wood panels production in France and Spain, but interestingly not in Portugal. Also, production in France has somewhat recovered since 2009, whereas in Spain the downward trend has continued. In fact, production in Spain has been cut to half in 2013 compared to what it was in 2007. Noticeably, the collapse of the housing markets strongly affected the panel industry, especially in Spain.

Contrary to the sawmilling industry, the panel sector is structured around global companies, which have better buffers against the downturn, and probably better chances to recover once the market conditions become more favourable. In the short term, the development will significantly depend on the competitiveness in the export markets as domestic demand is still low.

Future prospects in France may be better. France is the second largest producer in Europe after Germany, and has been able to maintain a high level of investment in the recent years: modernising production, moving towards recycled wood (current rate is over 24%) as well as installing boilers and co-generation facilities. Most of the production is also in the hands of global companies with 40% being exported. It has also benefited from capacity shutdowns in Central Europe, which has reduced competing supply. A recent outlook foresees a strong increase in production of 30–40% to 2020, mainly based in the momentum of green building. However, this could be jeopardized to some extent due to the increased demand of biomass for bioenergy production, and the impact of this on forest biomass prices. Supply tensions and price increases may also emerge once the forest biomass felled by storm Klaus in 2009 has been consumed by the markets.

Bioenergy development is both promising and challenging

Data for wood *biomass for energy* purposes is heterogeneous in quantity and quality in SWE, which makes it hard to analyse the development in the bioenergy sector. However, it is clear that the SWE development is behind Central European and the Nordic countries. This is partly due to the structure of the energy sector, which in SWE is much less reliant on combined heat and power (CHP) production for district heating. In France, for example, only 3% of electricity is produced by CHP plants, and only 2% of this is produced with forest biomass. District heating is neither well developed and only supplies 6% of all the demand for heating. Since 2005, however, the regulatory framework has favoured the installation of woody biomass-based boilers. While many of these developments are linked to traditional forest product mills, there are also some new standalone facilities. Partly due to these developments, total wood consumption is currently at 40 million m^3/a, including some 20 million m^3 of domestic and household consumption. Additionally, pellet production has grown to one million tonnes per year. While the forest biomass made available by the storm Klaus in 2009 has eased supply tensions in recent years, this will not be the case in the future. The increasing demand for wood bioenergy, coupled with the under-estimation of the difficulties of supply, are creating considerable tensions between the different players.

In Portugal, forest biomass-based bioenergy is mainly electricity generation, reaching 500 MW of installed capacity, of which 360 MW comes from CHP plants, usually integrated to pulp and paper mills. Additionally, Portugal produces almost one million tonnes of pellets per year from forest biomass. Questions are being asked concerning the future availability of forest biomass, given that the industry currently imports more than EUR 200 million worth of roundwood per year.

According to the Spanish Renewable Energy Plan (PER), Spain consumed 3.7 million tonnes of thermal energy derived from agricultural and forest biomass in 2010, with an installed electricity generation capacity of 533 MW, mainly at paper mills. The goal for 2020 is to produce 548,000 tonnes of supplementary thermal energy from biomass and to have 817 MW of supplementary electrical energy. Contrary to the French approach, PER identified new *energy crops* as a key element to meet the increase demand of forest biomass, with relative less attention to an increased mobilization of existing

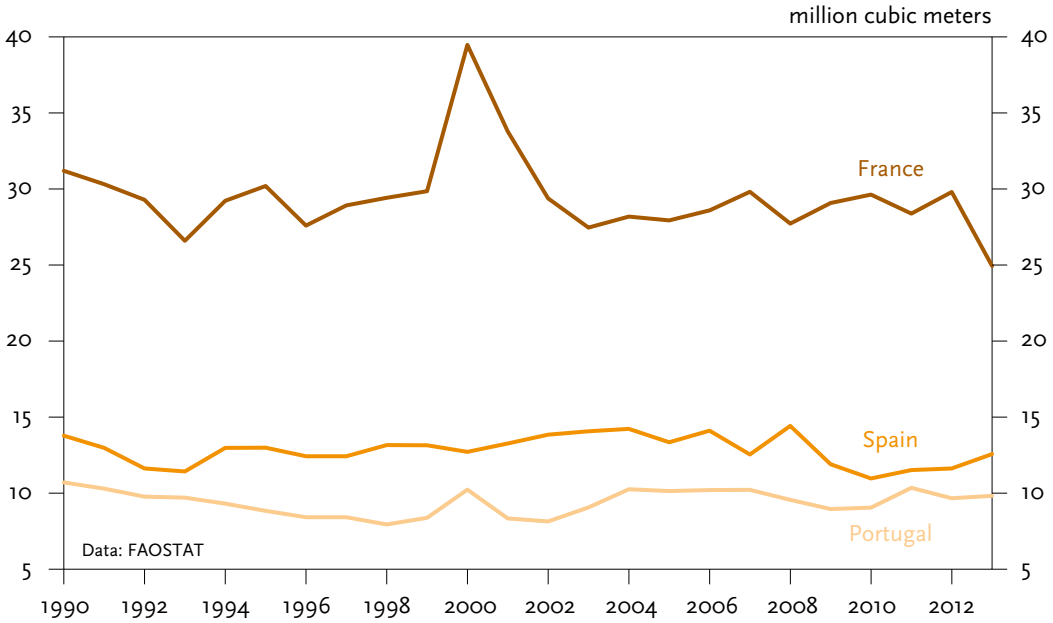

Figure 17. Industrial roundwood production in 1990–2013.

forest resources. Spanish pellet production capacity has risen from 60,000–600,000 tonnes, particularly due to sawmills trying to increase profitability by also producing pellets. Domestic demand for pellets is, however, below 100,000 tonnes per year. Despite these relatively mild developments, energy use is already the top destination for domestic woody biomass in Spain. Including industrial residues, it accounts for roughly 40% of total consumption, which is bigger than for the pulp (25%), wood panels (18%) and sawmilling (14%) industries.

The 2020 objectives for bioenergy might be difficult to reach in Spain, as the development of CHP plants has almost totally halted after regulatory reforms have significantly and retroactively reduced feed-in tariffs, coupled with a new tax on renewable electricity production. This sifting regulatory framework is also hampering the operation of plants that are already functioning, affecting the profitability of some paper mills. In a recent official document, the Ministry of Agriculture recognises that the lack of a stable regulatory framework for bioenergy is diverting investments to other countries. In Mediterranean regions, biomass is gaining political momentum as it is seen as the most feasible way to activate forest management and contribute to the prevention of forest fires. However, the lack of strong *traditional* forest supply chains and low stumpage prices are hampering actual developments as logistics constrains are difficult to overcome.

Future developments and lack of outlook studies

Apart from the Iberian pulp mills that have entered the bioenergy markets, there have not been significant developments towards the biorefinery concept. In France, the situation is also somewhat similar, although there are some signs pointing to establishing forest biomass-based biorefineries, such as the conversion of one Aquitaine paper mill into a biorefinery. France also has potential companies in green chemistry related

to the perfume, cosmetic and textile industries, which could help in boosting a new forest-based green chemistry sector in the future.

On the other hand, SWE is undoubtedly lagging behind in terms of the development and consumption of new engineered wood products (EWPs) such as cross-laminated timber (CLT) modules for buildings. Wood products mills do not seem to be able to mobilise the capital required for modernizing facilities or new product investments. Developments towards thermo-modified wood, for example, are promising but marginal in terms of revenues and resource use.

Although there are quite many SWE forest sector analyses available, many of them have a rather static approach: there is no reference to the main trends that have been identified in global markets, and only few provide medium or long term analyses. Moreover, there is a lack of studies that analyse in any detail the possible impacts of forest resource and roundwood market developments in the industry. For example, the French outlook study conducted by PIPAME in 2012 projects up to 40% increase in panel production, provided that the developments in the roundwood and raw material markets do not hinder this trend. However, there is no analysis of this, and what the different scenarios for the development would imply. This lack of more detailed market and forest-based sector outlook analyses and research is worrying.

Conclusions and implications

As the above analysis has shown, the development of forest-based sectors in France, Portugal and Spain share some common features, but there are also differences. Here, we try to summarize some general trends and questions that are important for the future developments.

- Driven especially by Asian demand, global pulp and paper markets are still likely to increase at least to 2020; however, large diversity in the development depends on the market region and specific product. One important question in this context for SWE is, whether the current competitive advantages and corporate strategies, including entry into the energy markets, will continue to allow the industry to maintain its position. Or, whether it will be forced to move more heavily into the new products and biorefinery markets, as is happening in other regions. With this respect, the Iberian producers seem to be in a better position than their French counterparts. Also, the high investment needs for new products and biorefineries may also require new actors to enter the sector, such as chemical companies and private investment groups.
- The current production of wood panels – particleboard OSB and MDF– amounts to around 7 million m^3 in Southern Europe. Different scenarios predict a 2.5–5% increase by 2020. However, the Southern European markets have greatly suffered from the long-lasting economic downturn and it is highly uncertain whether the sector will again recover to the pre-economic slump production levels. Such a recovery would require a political and societal impulse for green construction, so that increased wood construction and renovation could compensate for the long-lasting weakness in the housing markets. There are no signs that this will happen in the short term, especially in Spain and Portugal. In the coming years, the sector will be highly dependent on export markets. The pos-

sibility of higher stumpage prices would also reduce competitiveness, and may also prevent market share gains.

- The total production of sawnwood in France, Portugal and Spain in 2013 was 11 million m^3, which was 11% of the EU 27 production. However, this sector has important competitive weakness in SWE due to the very small size, old age and inefficiency of the mills, as well as the lack of internationalization and global positioning of the companies. In the context of globalized markets, and challenges in the domestic roundwood markets, such as possibly increasing stumpage prices, it is necessary for sawmills to increase productivity. This must be achieved through efficiency gains and by moving up the value chain, entering, for example, the EWP business on a much larger scale. Moving to EWP is also necessary in order to benefit from the momentum towards green building, a segment currently dominated by Nordic and Central European companies. The question is how the capital poor sector will be able to finance this movement and modernization.
- To date, the long-lasting trend of concentration of the wood products sector has not radically improved competitiveness and overall performance. Is difficult to imagine a sudden jump in competitiveness unless new actors come into the sector, such as foreign companies investing in sawmilling or EWP capacity and raising its competitiveness.
- The South-Western Europe forest sector is in many respects behind the development of the sector in many Northern and Central European countries. Yet in some products and in some SWE countries, it has grown in the last decade and could continue to do so in the future. However, the sovereign debt crisis and resulting changes in the regulatory framework have greatly slowed down the process, especially in Spain and Portugal. For example, the forest biomass based bioenergy development has been slower than earlier expected. However, the need to increase renewable energy is still continuing and could enhance the sector in the future.
- The impacts of these developments in other value chains have not been well evaluated. It seems, however, that in the absence of increased mobilization of resources, competition for feedstock will compromise the panel and even sawmill industries. This increased availability of resources requires, in turn, major investments in infrastructure and logistics, and will demand new organization, governance and business models. In Mediterranean Europe, it will require reinventing absent supply chains in many regions; this is not likely to happen without decisive public support.
- The wood producing Atlantic regions of SWE are in at a crossroads. The commodity oriented *business as usual* scenario is unlikely to be sustainable anymore. Current trends point towards a predominance of pulp and energy production, and even exports of roundwood to more competitive markets. This development can decrease the profitability, and even to some extent jeopardize the engagement of forest owners and society to the development of the forest-based sector. On the other hand, the path towards a higher added value and more diversified bioeconomy could increase the contribution of forests to economic growth and resource-efficiency. Indeed, making more out of the limited resources is an necessity. However, this will require, for example, a clear restructuring of the wood products sector and significant investments to move pulp and paper industry towards new products and forest biorefineries. It is a big challenge, and probably not feasible only through the current actors; it will also require new actors, as well as cross-sectorial and transnational partnerships.

- Mediterranean forests are also in a critical situation and could be increasingly *set aside*, unless a profitable forest management model is developed. Most countries and regions are putting their efforts in developing biomass markets and supply chains, even if the stumpage prices (profitability) are currently rather low. The question is whether biomass and forest products alone will be enough for the forest-based sector to stay viable in SWE in the future, and guarantee a balanced multifunctional forest landscape. If the answer turns out to be '*no*', it will be necessary to develop payments for ecosystem services' (PES) types of mechanisms to link forestry with existing strong sectors that could benefit from increased management levels (and reduced forest fire risk), such as the water and tourism sectors. Mediterranean forests are also in a big need to identify win-win situations and to develop new cross-sectorial partnerships, if they are to become economically sustainable.

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Roy, C. and Magrum, M. 2012. Meilleure valorisation de la resource forestière sous forme de sciages. Conseil general de l'alimentation, de l'agriculture et des espaces ruraux. Ministère de l'agriculture, de l'agroalimentaire et de la forêt, Ministère de l'écologie, du développement durable et de l'énergie Ministère du redressement productif. Paris. 77 p.

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7.

Conclusions and policy implications

Lauri Hetemäki, Hans Fredrik Hoen and Peter Schwarzbauer

Creative destruction

Based on the analysis of this report, one could label the current state of the European forest-based sector as one of *creative destruction*. The concept was coined by Joseph Schumpeter, who used it to describe the functioning of economy in the early 1940s. Schumpeter describes creative destruction a *"process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one."* This is a continuous evolutionary process that serves to maintain the vitality of capitalism, or market economy as we would call it today. It highlights the fact that some economic activities or sectors will eventually decline and vanish, while at the same time new technologies, products and business models will emerge. Consider the case of iron-hulled ships replacing those made of wood.

The analysis in Chapter 2 indicated that for the first time in history, graphics paper production has started to decline in many European countries, mainly because of digital media replacing the need for it. On the other hand, the production of some of the other traditional forest products (packaging products in aggregate, sawnwood) has been either low compared to past decades, stagnating, or even declining during the early years of the 21st century. The major factors behind this have been the increasing role of the emerging countries as forest products producers, and economic slump. The world manufacturing powerhouse of China, and the fast growth forest plantation superpowers in Latin America, are especially significant producers. The economic slump since 2008 has had a significant negative impact on European forest products markets. However, it is difficult to quantify to what extent these trends have been the result of the slump, and to what extent they have been due to structural changes that will also last once the economic upturn starts.

This development has many implications for the European forest-based sector. For the first time in the history, production of some of the traditional forest products is declining rather than growing in Europe. On the other hand, the development of sawnwood production in Europe is a big question mark. The long-lasting economic downturn has clearly been the major factor behind the bleak development for sawnwood since 2007. However, the economic cycle will eventually turn, and there will be significant building renovation needs in Europe, which will help to drive the sector's growth prospects in

the future. Also, many of the more value-added engineered wood products have shown strong growth in recent years despite the economic slump. Indeed, it is in these products that many of the Western European high-cost countries are likely to be more competitive in the future than in standard bulk sawnwood. In the latter product category, Russia and the emerging economies are increasingly challenging Western European producers' competitive advantages.

Given the above developments, industrial roundwood demand in Western Europe for the *traditional forest products* may decline in the coming decades. The changes in traditional forest industries production have also various implications on bioenergy markets due to many dependencies and feed-back loops, as discussed in Chapters 2 and 3. There is a need to reassess these dependences and their impacts on bioenergy production and forest biomass flows.

The structural changes have been one important driver for the European forest product industry to renew. This brings us to the positive, or innovative side of creative destruction. As Chapters 3–5 showed, many new opportunities have emerged for the European forest-based sector in the past decade. The forest industry is changing strategies and business models, and investing in new products, such as second and third generation biofuels, biochemicals and engineered wood products. Moreover, the changes in markets are also creating new demand for some old products, such as dissolving pulp and tall oil. Demand for dissolving pulp has been growing globally by around 10% annually in recent years; this growth is especially driven by the need to substitute cotton by other raw materials in the textile industry. The forest-based sector is also becoming more cross-sectoral as other industry sectors and investment groups are starting to produce new products and services based on forest biomass. In summary, the European forest-based sector will be in a major transition period in the coming decade.

One interesting concept emerging from the transition is the forest biorefinery, which was discussed in Chapter 4. A very closely related concept to the biorefinery is the *'bioproduct mill'*. What this means can be understood through an example. In Finland, a major traditional forest industry company is planning over one billion euros investment to build a bioproduct mill that would start operation in 2017. Although the mill's major product would still be pulp for paper in the early phase, it has some important novel features. First, the forest biomass will be refined into pulp, biomaterials, bioenergy, biochemicals and fertilizers, using no fossil fuels at all. It will be 100% based on renewable raw materials and side streams of the production process. Second, the operating model will be based on an efficient partner network with other companies also operating at the mill site. Thus, new products will be created in a collaborative network, which creates opportunities especially for SMEs to produce innovative bioproducts with high added value. The global big and often multinational companies may focus more on large volume and very capital intensive products, whereas SMEs may focus more on niche products. This could be one option to better utilize the opportunities and synergies that the bioproduct mill concept offers, and also become more resource-efficient.

Another development that creates new possibilities for many European forest-based operators, but which so far has been very much neglected, is the *services* related to forest-based products. Chapter 5 indicated that the forest-based sector is likely to follow the trend in other manufacturing sectors in OECD countries – the value added and employment in the sector increasingly comes from the services related to the products. The digitalization, or *the Industrial Internet*, has made it possible to develop new services related to the products (e.g. monitoring, remote servicing), and disaggregate the product

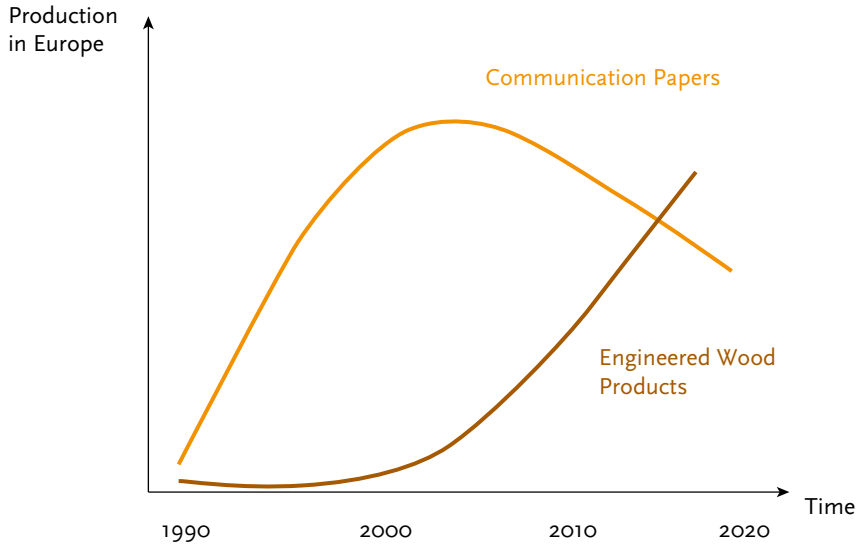

Figure 18. Example of the outcome of creative destruction.

value chains to tasks that may be produced in many different geographical locations and by a number of different enterprises. It may be the case, that increasingly in the future, the high-cost Western European countries focus their activities on services related to the new products rather than the actual manufacturing. However, as shown in Chapter 5, this possibility and its implications on the European forest-based sector have hardly been addressed in research, neither in EU forest or bioeconomy strategies, national forest policy documents or industry vision papers. Moreover, there has been no outlook on the development of services published. These shortcomings should be addressed in research as well as by decision makers.

'Direct' conclusions and implications

This report raises conclusions and implications that are both *direct* and straightforward, as well as *indirect* policy and strategic insights and openings for debate. First, we summarize the direct conclusions and implications followed by a discussion on policy insights and implications.

'Direct' conclusions:

- European forest products markets are facing structural changes that are caused by e.g., digital media replacing graphics papers, competition from emerging economies; the long economic slump (since 2008–); policies tackling climate change and boosting renewable energy; investments in R&D; and the renewal of the forest-based industries towards an emerging bioeconomy.
- The structural changes have caused some segments of forest industries in Western Europe to decline (graphics papers), stagnate (packaging papers, sawnwood), or increase (bioenergy, dissolving pulp, biochemicals, engineered wood products). New production concepts are emerging, such as the biorefinery, the bio-

product mill and prefabricated wood elements. Also, new actors are entering into the forest-based sector such as energy and chemical companies as well as private investor groups. The forest sector is gradually diversifying with forest-based activities covering a much larger entity than the traditional forest sector. Furthermore, due to the many synergies between the diversified activities, the sector is becoming more resource-efficient.

- The links between traditional (pulp and paper, sawnwood) and new (bioenergy, biochemicals, engineered wood products) products markets are many and significant. As a result, it is not sufficient to assess the long-run development of one product (e.g. pulp) without taking into account its links with other products (e.g. bioenergy).
- The assessments of EU forest biomass demand and supply for bioenergy production provide a wide range of results, and even the basic concepts used differ between the studies. Also, the studies often leave some important factor(s) out of the assessment (see below). All of these will have important implications on the quantity and prices of forest biomass demand and supply for bioenergy in the EU.
- The services related to forest-based products, and to the whole forest value chain, will be a big global megatrend in the coming decades, accounting for an increasingly larger share of the value added and employment in the sector. The traditional product value chains, in which one company at one geographical location was responsible for the whole production process chain, is changing to 'trade in tasks' and disaggregated product value chains. Many different enterprises, possibly in different locations, can be part of the production value chain providing different tasks, many of which are services rather than 'manufacturing' as such. The digitalization, Industrial Internet, and changing competitive advantages are important drivers for this development.
- In recent years, there has been a general agreement that there will be a growing demand for EU forest biomass in the future due to increases in the production of forest-based bioenergy, along with the traditional and new forest-based products. This view is supported by the more general megatrends of increasing global population and the middle class. The increasing demand and 'tightness' of forest biomass markets in the EU is a clear possibility. However, the existing expert assessments of the forest biomass demand and supply in the EU have tended to neglect some important market forces and dynamics, which were raised in this report. For example, the declining production of some current forest products and the emergence of new products, and the potential impacts of these on roundwood demand. Furthermore, there is a need for more through assessments on the impacts of international trade; the basic market and price mechanism; technological changes in biomass conversion; bioenergy production and biomass harvesting; new and increased competition for non-forest biomass sources (municipal waste, side streams from agriculture and food processing industries or aquatic biomass); and on the changing global competitive advantages in product value chains. Finally, it would be very important to assess what the services megatrend implies to the European forest-based sector in the future. If the above issues were properly accounted for, the results could still imply an increasing demand for forest biomass in the EU in the future, or not. We do not really know.

'Direct' implications:

- In order to provide helpful support for decision making related to policies, industry, forest owners, environmental interest groups and society in general, *it is necessary to update the long-term assessments for the European forest-based sector by taking into account the above conclusions*. In some important respects, the existing outlook studies are either outdated or incomplete, and may even lead to wrong policy conclusions. The most striking example of these is the long-term projections for graphics paper demand and supply in Europe, and their implications on the roundwood and bioenergy markets.
- It will take some time before we have the new assessments that take into account recent and expected trends. However, policy makers do not necessarily have the time to wait until more solid scientific evidence becomes available, they need to act even if the information is lacking. In such a case, decision makers should be made aware of the structural changes in the European forest-based sector and their possible implications. Indeed, raising the awareness of these has been a major motivation for this report.

Policy and strategy implications

'*For every complex problem there is an answer that is clear, simple, and wrong.*' This quote from Henry Mencken, a 20th century American journalist, is also relevant when we consider what strategies and policies are needed for the European forest-based sector in the future. The operating environment is many-sided, complex and continuously evolving, and there are specific regional characteristics and differences within Europe. The European forest-based sector is unlikely to be successfully supported by one overarching simple strategy or policy, although we might like it to be that way. Certainly, simplicity and consistency are virtues that should be pursued. But under the surface of a simple policy goal is often a more complex reality. For example, a catching 20-20-20 type of target is, in principle, simple; however, the policies needed to achieve this type of target are unlikely to be so, as we have already observed. Also, at an EU level, it may be better to focus on general strategies and policies, and follow the subsidiarity principle, rather than impose uniform, detailed and inflexible directives (see the section on *'Regional differences'* in this Chapter).

This report has raised many issues that are policy relevant, but for which it would also be unwarranted to provide simple and definitive policy implications or recommendations. Rather, we provide questions, insights and openings for policy and strategy discussions, which we consider necessary for being able to propose concrete policy recommendations. In the discussion of policy implications, we focus mainly on the EU. The EU covers already 28 European countries, and its policies and decisions are also closely followed, or to some extent even directly harmonized by some non-EU countries such as Norway and Switzerland. The EU also accounts for the bulk of European (non-Russian) forests, as well as forest products consumption and production.

The EU approach to forest sector based polices

The EU does not have a forest policy similar to its common agricultural policy (CAP). Instead, the EU influences the forest-based sector through its other policies, such as the *Europe 2020 strategy for growth and jobs*; the *Resource Efficiency Roadmap*, *Rural Development*

Figure 19. EFI ThinkForest science-policy forum meeting in the European Parliament. Photo: F. Rademecker

Policy, *Industrial Policy*; the *EU Climate and Energy Package* with its 2020 targets; the *Plant Health and Reproductive Materials Strategy*; and the *Biodiversity* and *Bioeconomy Strategies*. The visions, aspirations and strategies for the bioeconomy and the EU forest-based sector are expressed in European Commission documents, such as *'Innovating for Sustainable Growth: A Bioeconomy for Europe'* (ECBIO), *'EU Forest Strategy'* (ECFS), and *'A Blueprint for the EU Forest-Based Industries'* (ECFBI), all published during 2012–2013. These documents express key principles, strategies and actions needed to strengthen the EU bioeconomy, forest-based sector and multifunctional sustainable forest management. Here, we will reflect on these 'policy documents' in light of this report's analysis and insights. In doing so, we hope to deepen and focus the discussion needed for designing strategy and policy actions.

However, before moving to discuss the EU policy and strategy documents, it is important to acknowledge that there are other similar European and even larger-level policy processes on-going, which seek to enhance the forest sector bioeconomy or green economy. Most notable is *the Rovaniemi Action Plan for the Forest Sector in a Green Economy*, adopted by the UNECE Committee on Forests and the Forest Industry (COFFI) and the FAO European Forestry Commission (EFC). The Action Plan provides a platform for the forest sector to support the transformation to a green bio-based economy in Europe, North America, the Caucasus and Central Asia. The action plans clearly illustrates that the bioeconomy or green economy is not only an EU level process – much wider forums have set these as targets. Also, it is difficult to see how the grand targets that are behind the green economy, for example, could be achieved without global agreements and cooperation. The different regions, forums and processes strengthen each other in reaching the objectives.

The EU bioeconomy document (ECBIO) provides strategies and actions at a general level, rather than only on the forest-based sector, but can also be viewed as an overarching background for the forest-based sector. In fact, the ECBIO hardly mentions the forest-based sector. The document seems to have been driven, in particular, by the concerns over the agricultural sector. Given that in the EU countries there are more forest owners (16 million) than there are farmers (less than 14 million), the report could have been more balanced. Nevertheless, it outlines the general background for bioeconomy policies and strategies. The ECFS is the key publication for the EU forest-based sector, outlining strategies for enhancing and coordinating multifunctional forest management and diverse utilization for EU forests for multiple products and services. It is not very detailed on forest-based industries, and refers to ECFBI in this topic. It is the latter document that we discuss in more detail, after first addressing the more general issues.

Deeper linking of energy, climate and green economy to bioeconomy

First, the European Commission documents do not link the strategies and polices explicitly to climate and energy policies, or to the concept of a *green economy* (for definition, see Chapter 1.). Nor do they raise the land use issues between agriculture and forestry. All these issues are bound to be important on the road to a more comprehensive and integrated European bioeconomy. Moreover, as the forest-based sector, climate and energy polices, growth, employment and rural polices, the bioeconomy, as well as green economy concepts are all very much interlinked, it is helpful to address these simultaneously for strategic and policy purposes. The future of the forest-based sector should be assessed in the light of the overarching changes in the production and consumption patterns that must be made in the future to respond successfully to the climate challenge, the growing population and the huge increase in middle-class consumption patterns globally. This holistic approach is also necessary for analysing how the forest sector can successfully contribute to the European bioeconomy.

The green economy refers to a fundamental change in the economy as a whole, not only in the natural resource sectors. It practice, it seems to require an efficient price for carbon (in one form or another) and a decoupling of economic growth from (significant) increases in the consumption of energy, materials, and emissions, i.e., resource and environmental efficiency. From the policy arsenals available, *pricing carbon emissions is of utmost importance* to guide investments in carbon-free energy and the processing industry. A sufficiently high carbon price will change relative prices in favour of carbon-free solutions in both consumption and production.

Currently, however, the carbon price can be both a blessing and curse for the European forest-based sector. It is a blessing in the sense that it is necessary for production and investments in forest bioenergy, and other products based on forest biomass that may substitute products that are based on fossil energy or resources. It helps in renewing the forest industries towards a bioeconomic outcome. On the other hand, it increases costs and creates competitive disadvantages for energy-intensive forest industries (those which still use fossil energy), compared to the industries in other regions where the carbon price is lower, or there is no price for carbon emissions. Under this general conclusion, it should be noted, however, that the actual way how the carbon price is set (emission trading, tax, etc.), and whether it is set only for fossil fuels or also for renewables, will also impact the incentives and outcomes in the forest-based sector.

The issue brings forward the following perspective. Given that the EU forest-based sector wants to contribute on the front line in addressing the grand challenges of our times, and help the world to move towards sustainable societies or green growth, it has to accept that there is a need to pay for carbon emissions, even if many of the competing regions outside the EU are not doing so. If the possible competitive disadvantages created by the carbon price are compensated to those industries suffering adverse consequences, it should be done in a way so that it does not deflate the objectives and incentives created by setting the carbon price. However, at the same time, the carbon price may also be what some forest-based actors want – the higher the price of carbon, the more interesting and profitable the emerging forest biorefinery and bioproduct mill concepts may be. It is these biorefineries and bioproduct mills that are likely to produce both the conventional forest products, that are often understood to suffer from bioenergy and climate policies, as well as new products that benefit from the same policies. Thus, overall, the polices (carbon price) that enhance sustainable and green growth are also likely to benefit the European forest-based sector, at least in the long term. Unquestionably, there are exceptions to this which should also be taken into account.

Along with the increase of energy wood use by the forest industry, also the energy and chemical industries as well as private investments groups are increasingly interested in utilizing forests for new products or processes. This is, of course, a healthy development that could bring new capital and investments, know-how and diversity to the sector. It is also often at the interface of different sectors and businesses that new innovations are created. However, the development has also created some concerns amongst the existing players. In particular, there are concerns that renewable energy and climate policies might create a situation where incentives or disincentives to use forest biomass are created unfairly, depending on what purpose the raw material is used for. Thus, the production of bioenergy tends to be supported while paper and chemicals production are not. There is a question of the principal of creating a level playing field for all sectors, independently of what is produced from forest biomass.

Related to this, the *principle of cascading use* of forest biomass has also been raised. In essence, it means that there should be an 'order of using' the varieties of forest biomass streams, such as logs, pulpwood, residues, chips and tall oil, the most valuable parts of roundwood are used first for the highest value added or employment generating products (often argued to be pulp and paper), and then the side streams and residues are used (e.g. waste paper, chips) for low value added products (typically thought to be energy).

In line with the above thinking, the European Commission documents ECFS and ECFBI also promote the cascading principle. This principle is also justified by assuming that it will help to store carbon longer in wood products, in addition to helping generate more value-added and jobs. These are all good arguments, and it makes sense to follow the cascading principle *as a general guideline*. It should not, however, be followed slavishly and always since there are likely to be cases when some of the basic arguments behind it do not necessarily hold. Indeed, ECFBI acknowledge that in economic downturns, or in some locations with no alternative wood markets or energy supplies, or changing demand for fire prevention, there may be exceptions to this principle. In some additional respects, which the document does not acknowledge, the cascading principle may also become questionable. This is because the *value added is not a static concept but a dynamic one*. Also, *bioenergy is not a homogenous process or product*, but can be of many different things with different implications for value added, employment and the environment.

The single most important factor behind value-added development is typically the end (market) price of the product. The other important factor is technological development, which allows production costs to be cut, and/or changing the qualities of the products to be made (such as increased energy-efficiency). There is already evidence that in the past decade, the value added of paper vs. bioenergy based on forest biomass has changed significantly in some EU countries, and could of course do so also in the future. The value-added argument should not be taken as given; moreover, due to its dynamic nature, one should be very careful when trying to design long-term polices based on this principle. In the worst scenario, it could lead to a case where the less value-added sector is supported by policy at the cost of the higher value-added sector. As a general guideline, it would be desirable to let markets determine the competitiveness of the different sectors – for which purposes and in which order – the forest biomass is used. There may be exceptions for this, e.g. due to implications for public goods or bads (externalities) of some of the products or production processes.

Focus on structural policy issues

The ECFBI document states that the EU forest-based industries' share of EU GDP has shrunk by about 30% and employment by 26% over the last decade. The document suggests that this is the result of the on-going economic and financial crises. As a result, it argues that to overcome and reverse this downward trend, sustainable growth is needed, which must be brought about through increased competitiveness. In connection to this, it also draws attention to raw material (wood) prices. It foresees that increasing bioenergy production and the foreseeable 'shortage' of wood raw material in the EU will amplify this issue. The document implicitly still views the EU forest-based industries in the future as 'an own entity', consisting only of the current players and products. In essence, it is the current FBS that transforms itself to the new bioeconomy.

Based on this report and its background studies, we can agree with the ECFBI-document on the challenges that the FBS faces, and to some extent also the prescription as how to overcome them. To the extent that these challenges are due to cyclical factors (economic slump), the future economic growth and increasing the cost competitiveness of the sector will undoubtedly be at the root of the solution. Nevertheless, the document falls short of recognizing all the structural changes and the policies and strategies needed to tackle future challenges and opportunities. The severity of the digital media impact and the competition from emerging economies, and their implications, are mentioned, but not really addressed. The prescriptions as to how to tackle the future are thus incomplete.

According to the findings of this report, the structural changes are fundamental, and will not dematerialize with economic growth and cost cutting. First, there is a need to recognize the increasing role of new players in the FBS (the energy and chemicals industries, private investment companies, etc.), and what the implications for policies are from this. The sector is becoming more cross-sectoral and diversified, even the concept of *forest-based industry* is likely to change. Perhaps we need to talk about a bioeconomy sector in the future. Second, the increasing importance of forest-based product related services, and their implications on competitive advantage, value added and employment, skill requirements, research and development, and to policies are not really addressed

in any of the three EC policy and strategy documents. Given the analysis in Chapter 5, there should be much more strategic and policy discussion on these factors. Third, given the EU's strategy to also enhance the development and opportunities for SMEs, it would be helpful to discuss how the bioproduct mill (or biorefinery) concept could be one way to support this objective. Conventionally, the global, often multinational, pulp and paper companies, and the forest sector SMEs, have been separate entities that also need their own policies. However, as argued above, it would make sense to give policy incentives for those bioproduct mill investments that enhance the cooperation of big companies and SMEs, and synergies for new innovative products and business concepts. This could be promising for the development of the bioeconomy and important to address.

Forest biomass has been utilized for centuries for different products. With the emergence of new and the disappearance of old products, the utilization of wood as well as forest management has also changed, at least to some extent. For example, due to these transitions, different tree species may play a more important role or forests have been managed differently for raw material properties. Bioenergy and its implications to forestry is one good example. It would be surprising if the new forest products would not also lead to some changes in forests and forest management. For example, the composition and intensity of demand for forest biomass could change along with innovations and may create new requirements for forest management. Related to this, there is also a need to clarify the role of climate and bioenergy policies on forestry, improving relevant institutions and logistics of production chains, and fostering forestry research and development.

Although the focus of this report has not been on *non-market and ecosystem services of forests*, it is clear that the policies should be designed so that these objectives are not jeopardized. For example, the growing nature-based tourism industry and recreation will have specific needs on how forests are managed. Also, no matter what opportunities the future brings and how the forest-based sector contributes to the bioeconomy, the issues of *biodiversity conservation and climate sustainability* should remain high on the policy agenda of forest management. In this context, it will be important to continue those policies that help to develop further the multiple ways of utilizing forests, whether through the multiple use of *a forests*, or *forests specializing in one function* across regions.

More bioeconomy research – also a new type

The grand challenge for the EU (and Europe) is how to design and implement efficient and fair policies that help to move the European forest-based sector successfully towards the bioeconomy. These polices will undoubtedly be based on many 're': react, reduce, refine, reuse, recycle, replace, redesign, renew, rebuild, reform and be resilient. One policy, and 're', for which there is a large agreement and support and has a valid economic basis, is the policy to enhance *research and development* (R&D). Economic theory demonstrates that also in a competitive market economy, R&D is always suboptimal without public support, because technology diffusion does not allow the inventor (company) to reap all the benefits from the development while it has to bear all the costs. Thus, R&D creates a positive externality or spill-over to the economy as a whole and thus deserves public support. Instruments promoting R&D include public funding on research, subsidies on R&D, subsidies on technology diffusion, and pilot scale demonstrations.

It is not only a question of the quantity of research, but also about its nature. So far, the majority of bioeconomy research has focused on natural science and engineering

such as biotechnology, chemistry, and wood technology and genetics. This is understandable in light of the need to develop new products and processes based on forest biomass. However, the closer the new products come to the pilot and market stage, the more important it becomes to invest in social sciences-related R&D. The knowledge on economics, policies, markets and marketing, and social studies, for example, become essential to understand the opportunities, barriers, challenges and implications, and to support business and policy strategies. De facto, bioeconomy development will also require incentives and regulations as well as new business strategies and models. It will also have social and sustainability implications. For all these, social analysis is necessary in order to gain a deeper understanding on how policies and market forces interact and shape conditions for the bioeconomy, and the implications for future development.

The question of what type of research is needed also raises an issue that is very specific in the context of this report, i.e., how to best provide an outlook or systematically assess what future the bioeconomy could bring to the European forest-based sector, and how we could possibly impact that future. The key message in this respect is captured in the Epilogue below.

Regional differences – one size does not fit all

In terms of *forest resources* and *what forests mean for societies*, the regions and countries in Europe differ significantly, much more so than with respect to agricultural resources. For example, in Finland about 78% of the land area is covered by forests, but only less than 9% in the Netherlands; or in Poland over 80% of the forest area is owned by state, whereas in Portugal over 90% is privately owned. Due to these and number of other differences, it is clear that European forests and how countries and regions see their meaning vary. Chapter 6 of this report also discussed the region-specific characteristics of the European forest-based sector. In summary, when providing the future outlook for the European forest sector and designing the policies, it is essential to bear in mind regional diversity. Thus, there are many forest-related issues for which it may not make sense to try to impose *one size fits all* polices. But exactly for this reason, the situation also very much stresses the need for a systematic and informed coordination of different policies at the European level.

Recently, the European Commission *Bioeconomy Panel*, i.e., the expert group consisting of members from biomass producers, industry, policy, academia and civil society, produced a draft paper on 'Unlocking the EU's potential: towards sustainable and competitive supply of biomass'. In many places it stresses the need for regional policies and strategies in implementing the EU bioeconomy strategy. It recommends a *Sustainable Biomass Regions* approach, which would allow regional differentiated strategies that take into account the region specific natural (climate zone, soils, biodiversity), social or economic conditions in enhancing social and economic growth, while at the same time preventing environmental harm. It would be based on a set of rules *and* surveillance that ensure implementation and compliance of sustainability criteria at the regional level, for example. It is based on the view that successful sustainable production needs to be embedded in regional customs, practices and policies. The same line of thought that concerns sustainability seems to be required also for the cascading principle. For example, the regions may differ in terms of what are the possibilities for using forest biomass in certain order. By engaging and cooperating at the regional level, the policies are also likely to be more effective and get the necessary public support.

Clearly, while the regional approach will emphasize and take into account the diversity of the forest-based sector in Europe, at the same time it stresses the need for good cooperation and linking of EU level polices and strategies to regional and national level, among others. Not least because it is likely that there would also be the potential issues of providing a level playing field between the different EU countries.

Epilogue

Nassim Taleb, the Lebanese-American scholar, coined the term *black swan* to refer to an event or phenomenon that appears unpredictable, and for which we readily know how to develop an explanation after the event has taken place. Therefore, the phenomenon also appears *ex post* more predictable than it actually was. The black swan was a bird originally known only in Oceania – the Europeans did not believe that it existed until they landed in the region. Similarly, for example, the invention and rapid spread of the Internet, or the collapse of the Soviet Union were black swans to some extent. These fundamental events or phenomena do not seem to arise from past trends or the normal ('bell curve'), but rather from surprise, outliers or extremes. But how does this story of the black swan relate to this report?

The European forest-based sector is currently in a state of creative destruction. The sector is becoming more complex, cross-sectoral and interlinked. As a result, major institutional and market-driven structural changes are likely to occur during the coming decades. In order to change the forest-based sector to the bioeconomy, we first need to understand these changes. Therefore, there is an increasing need to anticipate the possible future developments and their implications. However, this task seems to grow ever more challenging due to the structural changes and complexities that induce such needs. Indeed, in the coming decades, the sector may face its biggest changes in a century. We do not know the future with certainty – the future does not simply exist today. Thus, there are bound to be surprises in the future.

With the time of accelerating and complex changes, and with the incentives of policy makers and company management to focus in the next few years, it is actually very challenging to incorporate long-term issues to present day decisions, however important it would be. The somewhat lukewarm attitude to take strong actions to combat climate change is one example of this situation. Given this, foresight work can be one tool to try to keep the longer time horizon on the decision makers' agenda. It will not change practices on its own, but without it would be even more difficult. Foresight work is thus not only of academic interest, but can have very practical policy and stakeholder implications.

This report has not aimed to provide systematic scenarios for the future, but rather illustrate, discuss, provide insights and open discussions on possible changes in operating environments and their implications based on existing studies. It only gives a glimpse of possible changes. By doing this, we hope to raise interest in more research as well as more thorough and systematic foresight and outlook studies on the future of the European forest-based sector. It is for these types of studies that the black swan analogy provides valuable insights. At least some of the studies should be based on a notion that there will be surprises in the future, and that we should try to capture these as soon as possible by providing a rich menu of outlook and foresight work. For this purpose, the traditional forest sector outlook studies, methods and approaches may still be necessary, but they are unlikely to be sufficient. The more diverse and broad-minded the outlook and foresight work is, the faster and better we are likely to observe the potential black swans of the European forest-based sector, and understand their meaning.

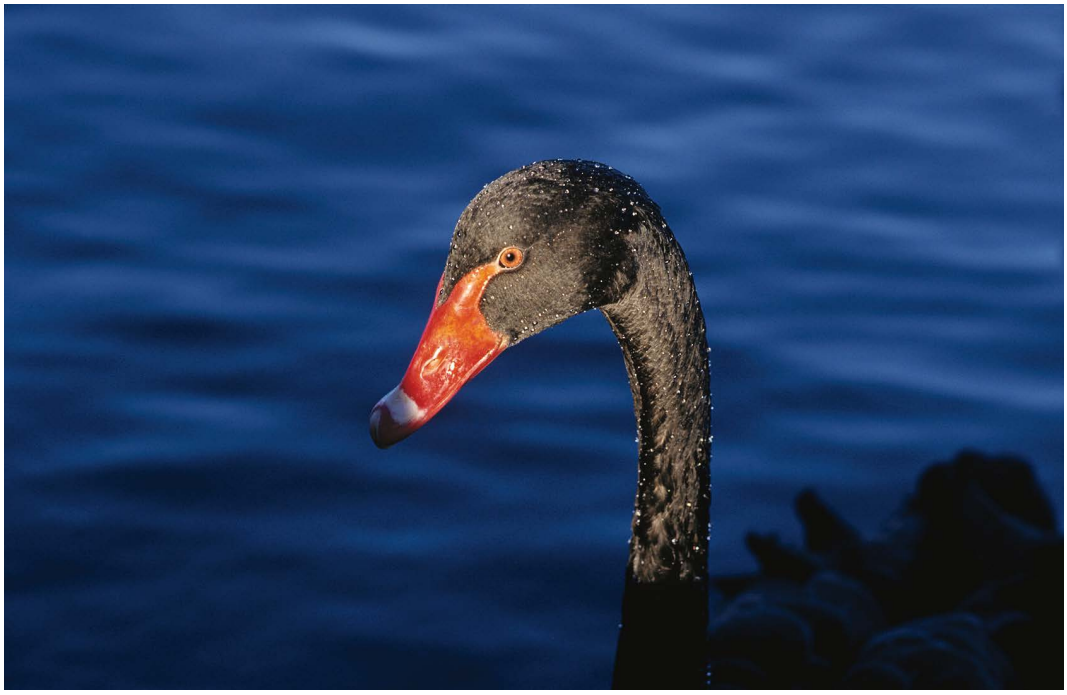

Figure 20. The black swan symbolises the unexpected but radical changes. Photo: Eeva Oinonen

Key messages

1. *Make a reassessment of the long-term outlook of the European forest-based sector in the face of the many structural changes*. In doing this, also use systematic foresight methods to tackle those developments for which we do not have the possibility to use data-based models. This is also necessary for generating a shared bioeconomy vision on which the strategies can be based.
2. *Be prepared for the impact and opportunities created by the services megatrend and the Industrial Internet*. In the future, a significant part of the value added and employment in the European forest-based sector is likely to come from services related to products, in addition to the actual processing of forest biomass. Also, *design the policies and strategies for a sector that is likely to be much more diversified and cross-sectorial than today*.
3. When designing polices, acknowledge the *regional diversity* of European forest-based sectors and the fact that it has somewhat different meanings in different countries. Although it is very unlikely that there is one overarching policy solving the challenges and creating opportunities, *place strong emphasis on the carbon price*. In one way or another, it is an essential tool in tackling climate change and helping to transform the European forest-based sectors to the new bioeconomy.
4. *Invest more in research, development and education* despite the fact that the economic slump and the needs to cut public spending might create pressures not to invest in such issues. This is necessary for the sector to renew itself and be globally competitive.
5. *Environmental sustainability and resource-efficiency are necessities*. Whatever polices and strategies are designed, these are crucial building blocks and must be included in them.

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EUROPEAN FOREST INSTITUTE

Yliopistokatu 6, FI-80100 Joensuu, Finland
Tel. +358 10 773 4300, Fax. +358 10 773 4377
www.efi.int

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