13 Innovative wood-based products, 2011-2012

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Highlights

- There are a number of different types of innovation: the wood-based products industry tends to focus on only two of these, namely products and process innovation.
- In the field of bioplastics, there have been a large number of effective innovations, specifically applied in the fields of hygiene and packaging.
- Bioplastic innovations are finding new market niches in the automotive and electronics industries, with good implications for future development.
- In the wood-based products industry, effective market innovations have been piloted to create new markets for innovative and existing products.
- There have been considerable advances and improvement in engineered wood products, including many new types of cross-laminated timbers (CLT).
- Many countries now have "showcase" CLT multi-storey buildings, demonstrating the effectiveness and carbon sequestration of this technique.
- The new engineered wood products have been taken up to a greater or lesser extent in different regions due to local building styles and needs, the existing timber industry, and extent of government investment.
- The new biorefineries are finding a niche market in the production of valuable chemicals. Demand is likely to expand in future as we reach or pass "peak oil", and market and organizational innovation are likely to be needed to adapt to this.
- In general, the wood-based product sector has been effective in new product innovation, but in future it will need increased use of market and organizational innovation.

13.1 Introduction

We are living in an era of innovation and in all fields of industrial endeavour new products and new uses are being discovered. This is particularly so for wood-based products as the world wakes up to the reality of the need for sustainable materials to mitigate negative impacts on our environment. It seems that every week someone finds a new use of lignin, a new function for paper, composite material or product from wood-supplied bio-refineries.

Recent research into using paper or lignin for electrical storage is particularly encouraging, for example, in the light of the need for renewable energy sources and the problem many of these have in supplying power at times of greatest demand. There has never been a time when so many alternative and diverse uses have been found for wood-based products, and the industry has never been so attractive to potential investment.

On the other hand, however, many people within the industry feel that investment and consumption has failed to mirror this excitement. Throughout the world, and particularly in the UNECE region, wood-based products have not always penetrated markets to the extent they could. For example, the newer wood-plastic composites (WPC) have proven popular and useful in the US, but have not yet achieved the same market penetration in Europe. Despite the availability of innovative and superior wood-based products, consumers are continuing to use non-sustainable products. In this chapter, we will explain some of the possible reasons for this.

Innovation can take several forms; and impressive though it is, product innovation may not be the primary type required by the industry. There is a tendency to promote wood-based products as "getting better all the time" rather than as the already practical and sustainable products they actually are. As befits a market review, therefore, in this chapter we will focus on innovative market-ready products and processes: tried and tested innovations that are about to, or have already, found a place in the market. We will also examine which type of innovation is the current focus of the wood-based products industry, and discuss the type of innovation that might actually be needed.

After an introduction to innovation generally, we look at market-ready innovations in a four particular sectors of the industry:

- Bioplastics.
- Bio-based materials.
- Engineered wood products.
- Biorefining.

We end with some general conclusions and recommendations on innovation policy and practice.

13.1.1 *Types of innovation*

A number of publications, notably the European Forest Sector Outlook Study II (UNECE/FAO, 2011), have pointed out that there are several different types of innovation. This bears repeating, as often only one of these types is treated as "real" innovation. In brief they are:

a. **Product innovation:** New or improved goods or services. This is only one type of innovation, but is generally what people think of when innovation is discussed: new products such as smart paper, or "solved problems" such as lighter, more competitive, wood-plastic composites.

b. **Process innovation:** A less exciting but equally valuable area of innovation. If a process can be made much cheaper, then a previously unprofitable product can become competitive. Today, this type of innovation is most important in the newer area of bio-refineries. At present, these are new and small in number, meaning that their products tend to be expensive and find niche markets (hard-to-produce chemicals for example). Innovations in process could lead to massive growth in the industry as it takes its place as a major supplier of products.

c. **Organizational innovation:** Linked to the above, but represents an innovation in a firm's business practices, whether internally or externally. An example of this may be the "linking" of sawmills with emerging district heating plants (DHPs) or combined heat and power plants (CHPs) currently being considered in many transitional economies, leading to a "package" of cheap and sustainable wood energy. No new products or processes have been innovated in this process, but the organizational innovation leads to a great reduction in cost, making an existing technology highly competitive.

d. **Marketing innovation:** Changing the perception of how the product is seen in the marketplace, by design, packaging or promotion. This is the challenge currently facing the cross-laminated timber (CLT) industry for example, with an excellent product which has proven highly successful in one region but fails to find a marketplace in another.

As a general rule, the focus within the wood-products industry has often been on the first two: new products and new processes. In the following sections we will look at the limitations of this approach, and provide examples of the power of the other approaches in bringing innovation to market.

13.2 Innovation in bioplastics

A good example of the general rule is bioplastics many of which have wood as the whole or part of their raw materials. These include various types of packaging and hygiene materials, cellophane or other cellulose-based materials, and new textile materials such as Tencel™. Despite frequently being more expensive than similar petrochemical-derived materials such as polythene or nylon, these products have found a distinct and profitable niche in the food and hygiene industries (e.g. packaging for take-away food, disposable nappies/diapers), these are products that have come under scrutiny for being bad for the environment, so bioplastics increase their acceptability.

There is a certain irony that these industries have tended to respond to public criticism not by cutting down on packaging and waste but by using packaging from sustainable sources (i.e. bioplastics). They have thereby been able to win back a degree of public approval. For example, in the UK, food companies will proudly display that their extensive packaging is sustainably sourced. Whereas from an ecological standpoint it would be better if they used fewer resources in the first place, one must concede that their switching to bio-based sustainable materials is at least a step in the right direction.

Bioplastics, however, are not necessarily more biodegradable than regular plastic and the advantage to the environment may not be as great as sometimes imagined. Also, despite their high consumer acceptance, bioplastics tend to be more expensive than their petrochemically derived equivalents. Nonetheless, the biopolymer market has enjoyed almost continuous growth since the late 1990s, with double-digit growth since 2005 and growth continuing despite the recession.

Estimates of global consumption of 203,000 tonnes in 2006 were set to increase to just over 500,000 tonnes in 2015 (Helmut Kaiser Consultancy, 2008). The trend is being borne out by the increase in global production capacity, which has been estimated in 2011 as 296,000 tonnes for the non-degradable biopolymers alone. This figure reflects commercial scale-up and continued investment in production of many biopolymers, but also great advances in bio-sourced polyethylene, and bio-derived polyamides, as well as the emergence of commercially competitive bio-derived or partially bio-derived thermosetting polymers for durable applications (European Bioplastics, 2011).

In addition to the non-degradable biopolymers, a further 428,000 tonnes of degradable polymers includes both bio-derived (e.g. thermoplastic starch, polyhydroxyalkanoates and others) and degradable non-biosourced polymers (e.g. polycaprolactone). The total of 724,000 tonnes is a major increase since 2003 when the pan-European consumption of biopolymers was a mere 40,000 tonnes (IBAW, 2005).

The network of biopolymer producers, users, and ancillary products such as bio-derived pigments, stabilisers, release agents, chain extenders and anti-static agents is increasingly well populated. This indicates the transition from an emerging to a growth market, and facilitates continued and rapidly expanding uptake of an available resource.

The three main areas of successful innovation in bioplastics are:

- Packaging
- Hygiene
- Consumer electronics

13.2.1 Packaging

We have already outlined some issues relating to the use of bioplastics for packaging. However, new products have increasingly replaced paper or board, especially as food-packaging material.

This, however, is often no more than a “visible” or “cosmetic” change; market penetration of bioplastics in the packaging that the consumer does *not* see has been much slower. Cheaper oil-based plastics still tend to be the industry standard. For example, food is delivered to supermarkets in crates, or shrink-wrapped on pallets, all made of standard, petrochemically-derived plastics. Whereas the packaging the consumer actually handles will proudly display a “sustainably sourced” logo.

The main growth area for bioplastics in packaging has been Asia, but these products are also well established throughout Europe and North America, and have generally increased in use with a market estimated at 200 million euro in 2010 and an expected growth rate of 18%-25% between 2010 and 2020. Advanced, biodegradable bioplastics have been particularly successful in Europe owing to supportive government policies on waste and recycling. Japan and North America appear to be following a similar pattern.

Examples of innovative products include Billerud’s Fibreform™, a stretchable paper that can replace much of the conventional plastic in packaging with little or no change in the production machinery. It is also a more stable material than many petroleum-based plastics (petroleum-derived) and is priced competitively. Similarly, a range of products have been developed based on wood-fibre cellulose, including clear films with good moisture-handling and heat-resistant properties, making them excellent competitors in the packaging of “ready” meals.

13.2.2 *Hygiene*

The ease with which innovative bioplastic fabrics and absorbent materials can be produced makes them excellent entrants in the highly competitive hygiene market. And better product designs can give these biodegradable products a greater appeal.

Innovative product design (a combination of product innovation and organizational innovation) can be seen in the integration of numerous bioplastics into a single new product, e.g. sustainably-sourced, biodegradable disposable nappies. Again, there is a similar pattern to the food packaging sector, where existing petroleum-derived products are replaced with innovative, competitive. Likewise, new bio-sourced super-absorbent polymers are continually being developed for use in the hygiene industry. In many cases, the innovation is organizational rather than product-based.

13.2.3 *Consumer electronics*

We already see a wide range of new bio-based materials in this growing industry, including materials used for mobile-phone cases and structure; connectors; personal computer housings; battery packages and chargers; electronic equipment chassis; personal music systems; and keyboards. Many new computer screens are made from cellulose-derived bioplastics and new applications are constantly being developed. For example, the first commercial applications of mouse and SIM cards from bio-based plastic are being launched.

Given the increasing awareness of the sizeable carbon footprint of consumer electronics – alarming in view of the industry's exponential expansion – there is much interest in the use of bio-based polymers to replace functional parts of these items, especially metals. Some companies have partnered to develop high-temperature bio-based polyamides whose properties would make them suitable for highly technical metal replacement applications in consumer electronics and automotive applications in cases where plastics could not be used before.

Examples of innovative products include Organic Light Emitting Diodes (OLED), a sustainably derived alterative to the now ubiquitous LED, potentially available to replace LEDS in computer and TV screens, as well as car headlights and numerous other uses.

The mobile-phone industry has been especially active in the application of bio-based plastics. Numerous manufacturers have presented their ecophones where the entire cover, the structure or parts are made of bio-based plastics. For example, a Nordic phone company has created a group of "environmental" devices that use bio-based materials. The company first introduced renewable raw materials in 2007 in its one phone model – with 50% of the plastics in the phone cover being bio-based, including structural-device parts.

Recent product launches of this company include the first mobile-phone to use bio-based paints in top and base coats. The company has many recent phone models that all use bio-based plastics. It is focusing on the structural parts, as the trust in the uniform quality of bio-based plastics is still not sufficient for use in visible parts. In its products, the company is also using recycled metals that are free of toxic materials.

Despite the success of innovations in bioplastics in penetrating a number of lucrative markets, the following issues remain that should be of concern to manufacturers and policymakers.

13.2.4 *Performance and cost*

In some cases, the bioplastic materials perform less well than their petroleum-derived competitors and are still more expensive. That is the main reason market penetration is at the more "cosmetic" end of the spectrum – packaging, hygiene products and electronic items that consumers handle and buy, reassuring them that they are not damaging the environment. This, therefore, is a good example of where product innovation is not enough, and more market and organizational innovation may be needed to promote and sell the use of bioplastics in less obviously "cosmetic" areas of industry.

13.2.5 *Public perception*

The danger in having a "green" reputation for sustainable sourcing is that many consumers assume that this means the product is biodegradable when it might not be – in much the same way that many assume that margarine has fewer calories than butter. This mistaken belief, while it may currently benefit the bioplastics industry, leaves them vulnerable to exposés and loss of faith in a product that currently makes its sales primarily on the basis of consumer faith. If the industry is to tout its sustainably-sourced credentials as a marketing tool, it must use product innovation to ensure that the product is also green in its disposal method.

13.2.6 *Political fallout*

Related to the above, many political commentators promoting "green" have expressed alarm that increased land use for raw materials for bioplastics may encroach on land otherwise needed for food production, touching on sensitive issues of world hunger and first-world privilege. Some excellent market innovation in making non-conflict with food production part of the promotional and advertising strategy was made by a Nordic phone company.

13.3 Innovation in bio-based materials

In this chapter, when we use the term "bio-based materials" we are referring to composite materials, one component of which is wood (often in the form of fibre or flour) or plant fibre. These are distinct from the traditional wood composites such as MDF or particle board, as the matrix component in WPCs is a more continuous phase and thus .a greater proportion of the product weight. These new products also tend to use finer wood particles or fibres, bonded with a variety of (usually) plastic based materials.

The most common examples are wood-plastic composites (WPC), well-established materials used in non-structural construction components, which continue to be innovated, developed and proliferated. At any exhibition of wood-based products, you are certain to be surprised by new composite materials that have been developed for use in maritime, automotive and even aerospace applications.

Apart from innovations that lead to new uses for these versatile materials, the number of products that use recycled or bio-based plastics has also grown, enhancing the products' green credentials. A further welcome innovation is that of "foamed" WPCs, which are much lighter than their predecessors.

In 2009, global WPC demand was about 2.6 billion euro. By 2011, decking was projected to be the largest end use, accounting for 44% of demand. Despite the beauty and usefulness of these products, particularly in outdoor applications (e.g. decking, window frames) where despite strongly resembling natural wood they need no painting or weatherproofing, market penetration has been patchy. In a nutshell, WPCs are a well-established product in the US, with innovative variants taken up readily by various industries. In Europe, however, take-up has been slow (though improving) and is low in Asia, although production there is expanding rapidly. The European and Asian markets show a greater prevalence of natural fibre composites in the automotive sector – using long fibres such as flax, jute, hemp, kenaf and others.

The WPC market has grown steadily since its inception in the mid-1990s, with growth only faltering slightly in 2007, just before the financial crisis. At this point, global WPC production (including thermoplastics filled with other natural fibres) was estimated at 900,000 tonnes. Despite the downturn, growth continued, with European production reaching 193,000 tonnes in 2010.

Sustained production in South America and in east Asia for the automotive sector – and a sector-wide continued growth due to the increasing weight of secondary components per vehicle being moulded in natural fibre composite – will have dampened the effect of the financial downturn in the construction-dominated North American WPC market. However, in many regions the repair, improvement and maintenance market remained steady through the recession period, as homeowners opted to improve their homes with simple upgrades while the market was weak, benefitting WPC decking and fencing producers.

Steady improvements in blending and moulding technology during the first decade of this century led to greater potential for injection moulding of complex forms, with high quality and low shrinkage on exiting the mould. Fibre reinforcement in moulded components has become more common, opening markets in furniture, household goods, stationery and electrical. There has also been a gradual exchange of the matrix polymer from polyolefins to biopolymers in items where the bio-content was important to the product's green credentials, to its end-of-life considerations or to the consumer preference. Bio-degradable plant pots are one common example of combination of wood flour with biopolymer for short life-span products.

Excellent new products are being readily taken up in North America – products that have low or no sales elsewhere. It would, however, seem that there is a strong need for marketing innovation of some kind, as shown by, for example, the WRAP group consultancy, which published a market strategy for innovatively promoting WPCs in Europe (Optimat Ltd & Merl Ltd, 2003). This remains an excellent model of innovative marketing, examining the reasons the product and its innovations were not taken up by European markets and coming up with novel marketing approaches to overcome this. Innovative marketing strategies included targeted use of public-access trade fairs (such as the British Ideal Homes exhibition) to allow the consumer to handle and view the product directly, as Europeans often seem to have the attitude of "accepting no substitutes" when it comes to wood, and may be unaware of how wood-like WPC can be.

The industry went on to lobby the various large supply chains in the UK, for example, where a small number of national chain stores supply almost the entire country with products of this kind. As a result of this lobbying these chain stores began carrying WPC products as part of their range. Traditional avenues such as TV advertising were not adopted. The WRAP analysis showed that the primary resistance was concern about the look and feel of the product, and this cannot be determined from a television or magazine advertisement. All efforts were geared towards encouraging consumers to physically encounter the product. One key development for uptake of WPCs in DIY decking and similar products has been the development of foams to reduce product weight. Extruded foamed core sections, as well as textured surfaces, increase the "feels like wood" appeal of the product.

Innovative composite materials are finding markets outside their traditional home of the construction industry. One exciting development in this area is the increased presence of wood composites in the automotive industry. Once again, this is nothing new: the East German Trabant car used composite materials in its bodywork, as these were cheaper than steel (as well as lighter, and thereby adding to its fuel efficiency).

More modern examples include a system provider for the construction and automotive industries. Its automotive business line provides interior systems including seating, overhead, floor, door and cockpit components and modules. Its key bio-based material products are natural-fibre-reinforced moulded panels and structures. The company is developing a natural-fibre-enforced, biopolyol-based headliner, which is expected to reach the market in 2012.

Another example is provided by an automotive supplier that specializes in seats, vehicle interiors, front ends and emission-control technologies. The company's key bio-based material is wood-fibre-reinforced plastic panels. Through its position in the network, the company can both provide a path for new bio-based materials and actively develop new ones for its products.

Innovative new foams based on cellulose or vegetable oils have been developed as a direct sustainable substitute for most of the petroleum-derived foams used in car interiors. Composite and bioplastic foams tend to weigh less than their competitors, making them competitive on issues other than green credentials.

Sweden appears to be a market leader in this area, with a Swedish company developing a range of functional products, as well as participating with a car company and others in developing the "virgin car", a car made largely from bio-based materials.

Manufacturers of bio-based materials have had to undergo much organizational innovation to adjust their methods to the well-established "just in time" methods of the automotive industry. This serves as a good example of when product innovation is simply not enough. The product is excellent, but if it cannot be produced in a flexible and controllable fashion for an established industry, it may as well not exist. Organizational innovations have included shorter stock rotation times, faster processing and fewer process steps.

Finally, in addition to the more well-known WPCs, bio-based materials also include advanced materials often used in insulation: wood-based insulation wool, wood-fibre insulation boards and bio-based insulation foams. The raw material for these can be virgin pulpwood, recycled newspaper, a wide range of natural fibres or soybean oil. Cellulose-based insulation producers are usually small companies with large competitors in both raw material and end use, but are achieving successful market penetration, mostly by promoting the green credentials of these insulating materials compared with fibreglass or petroleum-derived products.

In conclusion, we can see that the bio-based-materials industry has shown an effective grasp of the four innovation principles, not just innovating new products and processes, but also new market approaches and organizational innovation to compete effectively with non-sustainable products.

13.4 Innovation in engineered wood products

Engineered wood products are not in themselves innovative. Plywood, in one form or another, has been around for over 100 years, and even more novel products such as cross-laminated timber (CLT) where, instead of plies, bonded, cross-laminated single layers ('lamellas') are used. These may be held together either with glue or dowelling and have been in production since the 1990s (Augustin, Blass et al (2009): Steurer, 2006). Newly developed products such as Brettstapel, Holz100 or Appenzellerholz are gaining market shares, especially in central Europe (Bresta, 2012; Kolb, 2008; Studiengemeinschaft Holzleimbau e.V., 2010). These and other innovative products are industrially produced, with wooden lamellas held together with dowelling or newly formulated strong glues. (figure 13.4.1).

FIGURE 13.4.1

Notes: "Brettstapel" board; the plies are held together through long kiln-dried plugs made of beech which are inserted into pre-drilled holes; as soon as they absorb the moisture from the environment they swell leading to a strong bond between the different wooden parts of the board.

Source: James Henderson, 2010.

These products are generally produced in the form of large-format planar elements. Softwood (spruce, fir) plies or laminations form the raw material for these elements.

The advantages of these and the newer glued plies is that they are well matched to modern methods of construction. Wooden buildings have traditionally required special construction methods, based around a timber frame, which these strong flat panels do not require, allowing architects to create multi-storey buildings that strongly resemble existing structures, facilitating vast glass surfaces and open, modifiable interiors (figure 13.4.2)

FIGURE 13.4.2

Note: The world's tallest modern timber residential building, "Murray Grove" (UK), 2009.

Source: Will Pryce/proHolz Austria, 2012.

Furthermore, elements can be assembled in the factory to form walls complete with the necessary openings for doors and windows, accurate and ready for erection. Piping and wiring can similarly be placed within these prefabricated structural elements. Such innovative products can therefore begin to take an equal place with concrete and steel, instead of timber buildings being special and unique structures. The new products also have several advantages over their traditional rivals: despite being lighter, they provide more thermal insulation. They have high load-bearing and energy-dissipation capacity (e.g. earthquake proofing), as well as providing excellent fireproofing and acoustic properties.

Finally, buildings erected with solid wood panels provide excellent environmental values. It has been shown that the greenhouse-gas emissions of a multi-storey building are more than 10% lower than a similar masonry building over the life of the building (Aeschbacher et al., 2012) (figure 13.4.3). Further, the panels can be lined on the inside with gypsum boards or left exposed, the latter significantly reducing the amount of embodied energy within a building.

All these advantages come with the well-known general advantages of wooden structures: lightweight construction, dry building material (no drying times), short construction times (prefabricated elements/modules) and carbon storage.

FIGURE 13.4.3

Note: 1,198 tonnes of stored CO_2 equivalent: the largest solid timber building in the UK, "Bridport House".

Source: Ioana Marinescu/EURBAN Limited, 2012.

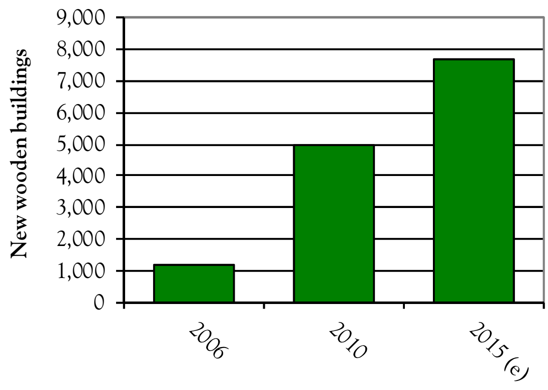
Despite their obvious advantages, take-up of these products has been uneven in the world construction market. The products are widely used in Austria, the UK, Switzerland, Germany and Italy. Austria is the market leader, and the UK and Germany show great potential in the short term. In the last five years, CLT production in Central Europe has grown by 20-30 % per year; and in 2011, 400,000 m^3 of CLT elements were produced in Austria, Germany, Italy and the Czech Republic – 70% of this in Austria (Plackner, 2012a, 2012b).

Although in 2006, only 3,400 m^3 of CLT were used in the UK, the figure climbed to 25,000 m^3 in 2011, mainly due to government-sponsored public-sector projects. However, demand in this sector has recently dropped significantly as a result of government cutbacks in public spending. The future market is thought to be in multi-storey residential building, especially in London with its housing shortage, where these products are seen as a competitive building material (figures from interview with Mr. Zumbrunnen).

In Italy, the use of innovative wood products has greatly increased, especially since the destructive earthquakes in the region of Abruzzo (L'Aquila) in 2009 (graphs 13.4.1 and 13.4.2)(Gardino, 2011).

GRAPH 13.4.1

Growth in numbers of new wooden residential buildings in Italy

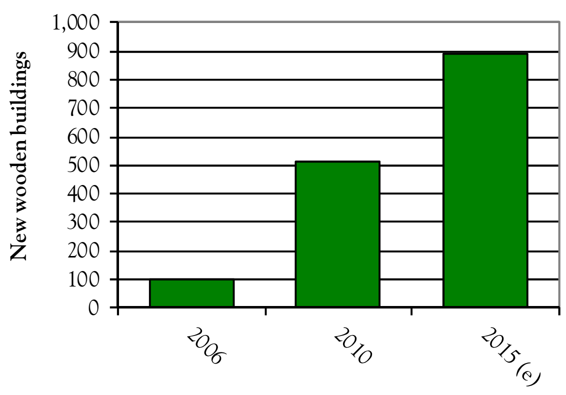


Notes: e = estimate. In 2010, 33% of these wooden apartments/buildings were made with CLT. In the reconstruction of L'Aquila, the share of CLT was as high as 41%.

Source: Gardino, 2011.

GRAPH 13.4.2

Growth in numbers of new wooden non-residential buildings in Italy



Notes: e = estimate. In 2010, 33% of these wooden apartments/buildings were made with CLT. In the reconstruction of L'Aquila, the share of CLT was as high as 41%.

Source: Gardino, 2011.

Despite Switzerland's position as the creator of many of these innovative products, its production is relatively small compared to Austria, as it has a smaller export market. However, in collaboration with the Swiss Federal Institute of Technology and other institutes, manufacturers have continued to undertake research and development. It therefore seems probable that Switzerland will continue to further develop these products (Holzkurier, 2012).

Beyond the countries already mentioned, the use of such products in France and Spain is much less but is showing strong signs of increasing, with much more successful sales than traditional timber buildings. As countries in southern Europe have a culture of construction with masonry and concrete, an increase in solid wood construction requires new local architectural knowledge and experience. Furthermore, the warm climate (especially in the south of these countries) requires buildings with heat storage capacity that is better provided by CLT products than traditional lightweight timber construction. In the medium term, France, in particular, has good potential as a CLT buyer.

Further afield, there is less knowledge and demand for CLT products. The CIS and China find it prohibitively expensive to import these products from Europe, although there are hopes for a Russian-manufactured substitute. In the Nordic region and North America, the homelands of wood construction, these innovative products are not widely used, despite Norway's having embarked on construction of a "showpiece" 22-storey wood-panel building, which will be the tallest wooden building in the world. However, demand is increasing in Canada, with three CLT plants in production. Finnish interest too has been strongly positive (Nanaev et al., 2010; Ridenour, 2012).

In all these new markets, the issue is not one of a need for product innovation. Innovative, effective products exist, and their usefulness and competitiveness have been shown in a number of markets. These products do not need the same organizational innovation that was required of, say, foamed bioplastics. They are ready to slot right in to existing construction methods and preferences. What could be needed is market innovation that would expose builders of large construction projects, or the city governments that commission or permit them, raising awareness of the advantages of engineered wood products.

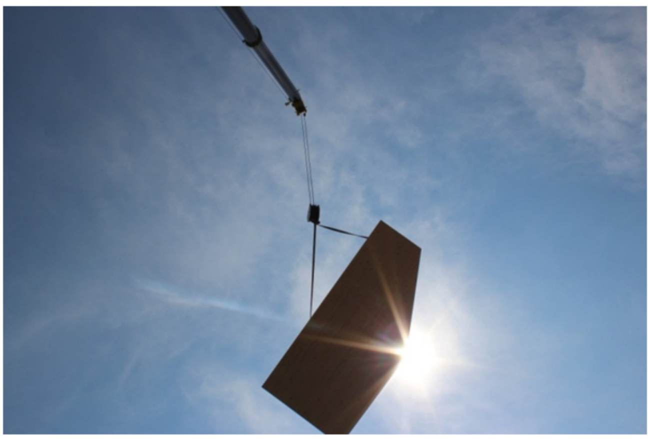
Model projects, such as the Norwegian or UK buildings, go some way to demonstrating this. Unfortunately, public knowledge of these projects is low. Most Londoners are unaware of this remarkable wooden building in their city.

Although showpiece houses have also highlighted the possibilities of this building method, much more market innovation clearly needs to take place before the European success story can be repeated in North America – particularly given the mature market for conventionally designed timber houses in that region. It may be that the best opportunities, at least initially, for CLTs are in areas of North America needing expedited construction, or in more remote regions where on-site fabrication is limited by climate, availability of materials and where skilled carpenters might be in short supply. This particular niche is well suited for CLT construction as they are shipped to the building site in a ready to assemble state (figures 13.4.5 and 13.4.6). Further niche opportunities may be available in areas where the greater earthquake-proofing CLT can provide is needed.

FIGURE 13.4.5

Note: Roof assembly with CLT boards on a glued laminated timber primary structure.
Source: Schilliger Holz AG, 2012.

FIGURE 13.4.6



Note: CNC-machined CLT board being lifted to its position.
Source: Schilliger Holz AG, 2012.

13.5 Innovation in biorefining

As biorefineries are themselves something of an innovation, the term "innovation in" may be something of a misnomer here. While it has been known for over 80 years that wood could form the basis for producing several chemicals currently refined from oil, developing plants to do this is comparatively recent. Most of these plants are "pilot projects" to test how well this model of production works and to see if it can be extended to a cost-effective commercial-scale.

These innovative factories have succeeded in producing organic chemicals that are generally expensive and hard to source, but biorefining is still something of a niche market rather than a fully viable industry. Basic practical problems to be overcome include the fact that there are not enough trees in the world to produce enough oil for current needs. For as long as the world economy continues to be petrochemical-based, biorefineries are likely to have principally a complementary role.

In this scenario, we see product innovation as being the right strategy. For example, new technologies have made the production of carbon fibre from biorefineries a distinct commercial possibility. Given the many uses of carbon fibre and its high cost, this is welcome news, and a range of other biorefinery commercial applications are being researched. And as supplies of oil become scarcer, biorefineries become more competitive – not as a way of supplying liquid fuels but of the other products and platform chemicals derived from oil, and that are much less likely to damage the environment. There may, however, be a need for market innovation in selling the somewhat complex message that the world needs to wean itself off its hydrocarbon habit. But while it still has one, biorefineries can fill part of the gap.

13.6 Conclusion

We are seeing today a tremendous proliferation of useful and innovative wood-based products, with new ones being invented or discovered all the time. Many of these wonderful innovations may not find a significant foothold in the marketplace, not because of any lack or failing, but because focusing on product innovation exclusively cannot make a successful innovative product.

UNECE is in a unique position to make cross-country comparisons, as shown above, to demonstrate that producers of innovative products can succeed if they address the following challenges:

a. **Lack of process innovation:** where the product exists, but is too expensive or time-consuming to produce – an issue that was successfully tackled in, for example, the biorefining industry, which can produce some organic chemicals more cheaply than petrochemical plants.

b. **Lack of organizational innovation:** where the product cannot "match up" with existing industries that are willing to use it – as successfully tackled by those bio-based products manufacturers who are working closely with the automotive industry.

c. **Lack of market innovation:** where the product is good and useful but unheard of or disliked for some cultural, or seemingly irrational, reason – the success in marketing WPC in Europe is an excellent example of market innovation, where the cause of resistance was identified and an innovative marketing strategy applied to overcome it.

The wood-based-products industry still has challenges in making its innovative products available for everyone. However, the market prospects for these sustainable and useful products are promising.

13.7 References

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