WOODBRIDGE ASSOCIATES™

Lignin-Fibre Composites

Commercial Opportunities for Alberta Producers

BUSINESS CASE

Prepared for Alberta Finance and Enterprise (AFE)

April 2010

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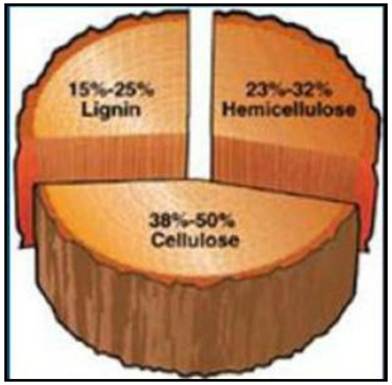
Chart 2



Richard Gosselink RRB4 Rotterdam 2008

1. What is Lignin?

The focus of this report is the potential to use lignin fibre composites in Alberta's window and door manufacturing industry. Lignin is a carbohydrate, and natural complex-polymer found in combination with hemi-cellulose and cellulose in the cell walls of trees and plants (Chart 1). It helps stabilize the living plant partly by reinforcing cell walls, preventing them from collapsing, and partly by regulating the flow of liquid. Lignin has been long recognized as being one of the most abundant renewable raw materials available on earth. As a natural product, it has a 'green' genesis. It has several chemical and bio-physical attributes which potentially could make it an attractive feedstock for numerous applications which require natural plant derived polymers – including 'liquid plastic'.

Lignin is produced as a commercial compound, along with more significant volumes of lignosulfonates (see later pages). But the overall volumes currently produced are a small fraction of the material's potential yield. Much of the lignin consumed by various industries, such as the pulp and paper industry, is used up as part of the overall pulp making process. Only recently has the value of lignin as a separate 'product' started to become recognized, notably currently for bio-fuels (energy production) and potentially for a wide range of higher value polymer end-uses. The global and provincial (e.g. Alberta) potential is substantial, because lignin represents 15%-25% of the volume of all trees (Charts 2 and 3), and a significant portion of the woody volume of agricultural plants.

Chart 1

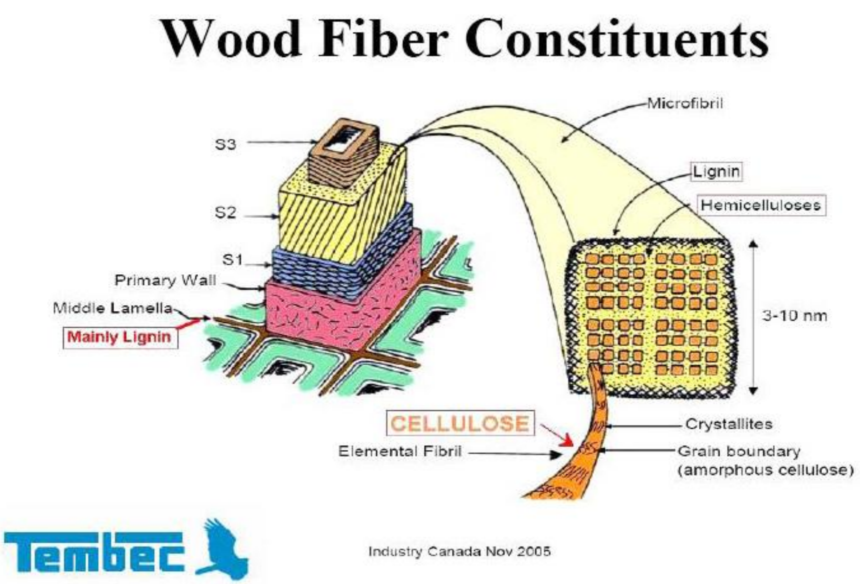
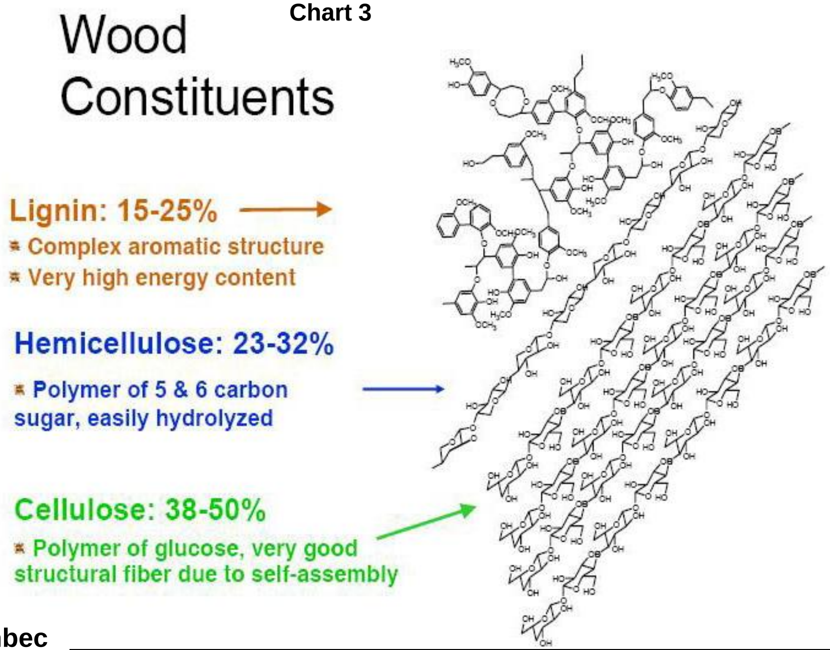


Chart 3



Source: Tembec

2. What are Lignin Fibre Composites?

Lignin fibre composites are materials which combine various proportions of lignin together with other natural fibres and additives, and sometimes petroleum-based compounds, to create specific desired characteristics. Many of these composites are designed specifically as 'green' alternatives to displace petroleum-based plastics. There are 'pure green' versions, which mix lignin with fine natural fibres made of wood, hemp or flax and natural additives such as wax. In Germany, the **Fraunhofer Institute** has developed a technology of this type and, through a commercial firm – ***Tecnaro*** – produces and markets a proprietary thermo-plastic granulate ('Arboform', Chart 4) used for injection moulded wood applications (see later page). The material is being used for making car interior parts and various other applications, potentially including commercial scale mouldings and doors (Charts 5 and 6). Reportedly, one of the advantages of '**Arboform**' over conventional plastics is that it shrinks very little on moulding. For the lignin-based application being considered for Alberta in this report – plastic and composite windows – this would be an important attribute.

In Canada, **GreenCore Composites** is a spin-off firm created by the Innovations Group at the University of Toronto (TIG) to commercialize natural fiber composites technology. The firm has targeted the significant potential which exists for this technology in Ontario's auto sector. GreenCore reportedly also has conducted prototyping trials in furniture, toys, and household products applications. The firm's plastic pellets can be processed within conventional injection moulding equipment and may be coloured and compounded with standard moulding additives.

With funding assistance from the Government of Ontario, GreenCore operates a pilot plant in Toronto for product development and to produce commercial quantities of composite material for testing and validation with potential customers. GreenCore apparently began commercial sales during 2009 in the lawn & garden market.

Within the field of plastic composites, there also are starch-based compounds which frequently are used as 'hybrids' in combination with petroleum-based plastics. **Cereplast (**next page) is a good example. Plant derived plastics based on polylactate, thermoplastic starch (TPS) and polyhydroxybutyrate (PHB) have been being injection moulded for years.

Chart 6

Source: ARBO

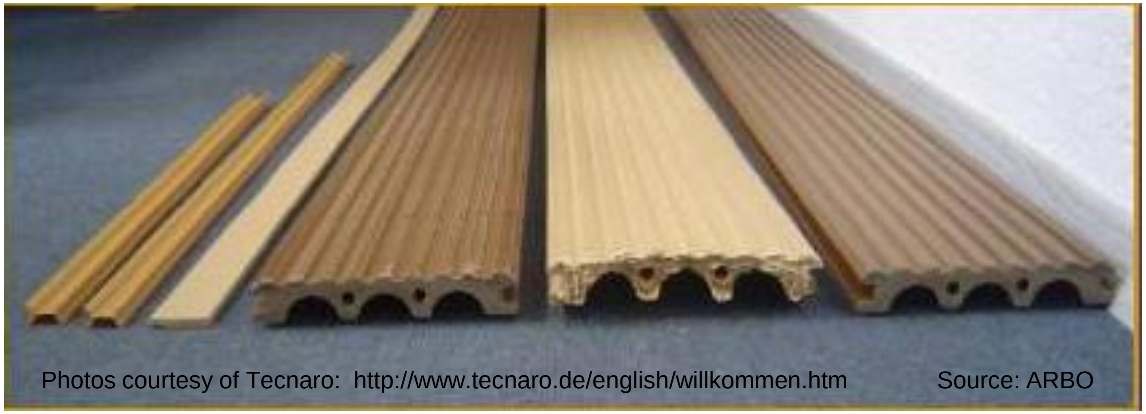
Chart 4

Source: ARBO

(Left) Chart > shows Arboform 'plastic pellets' produced by Tecnaro, alongside one of its test products manufactured using injection moulding technology.

(Right) Chart > shows an example of 'liquid wood' mouldings also produced using Tecnaro 'Arboform' pellets

Chart 5



Photos courtesy of Tecnaro: http://www.tecnaro.de/english/willkommen.htm Source: ARBO

2. What are Lignin Fibre Composites?

'Composites' refer to carbon fibres mixed with an oil-based resin to form a reinforced plastic. They are fibre reinforced polymers. Fibreglass and Kevlar reinforced plastics are well known examples. Bio-composites use natural resins and natural fibres for the reinforcement, and are bio-degradeable and recyclable.

Non-Lignin Products and 'Hybrids'

Petroleum-based plastics are well-developed in the market place, versatile and generally inexpensive (i.e. in terms of direct costs: see later discussion regarding the societal costs of slow rates of waste decomposition, plastics pollution and low levels of recycling). Clearly, petroleum-based plastics are the established 'players' that command a dominant market share in a vast array of end-use applications. In this sense, virtually all natural polymer and natural fibre composites target the overall plastics market for their potential growth, and most (because they are limited to specific attributes and performance properties) are designed to displace specific types of petroleum-based plastics. Not surprisingly, especially with the growing importance of being 'green', petroleum-based plastics manufacturers are willing to consider 'hybrids' which combine hydrocarbon with carbohydrate materials. Several innovative bio-plastic firms have emerged to meet this need.

Cereplast Inc., based in California, manufactures proprietary 'pure' and 'hybrid' bio-plastics from starches (corn; what, tapioca and potatoes) which are used as substitutes for petroleum-based plastics in the major converting processes such as injection molding, thermoforming, blow-moulding and extrusions - at a pricing structure that is reported to be competitive with petroleum-based plastics. As one of the firms on the cutting-edge of bio-based plastic material development, Cereplast offers resins to meet a variety of customer demands. Cereplast Compostables Resins® have 100% renewable content and are 100% de-compostable. They are suited for single use applications (Chart 7) where high bio-based content and compostability are advantageous, notably in the food service industry. Cereplast Hybrid Resins® have approximately 50% renewable content. They combine high bio-based content with the durability and endurance of traditional plastics, making them ideal for applications in industries such as automotive, consumer electronics and packaging (source: Cereplast www.cereplast.com).

Chart 7

Source: Cereplast

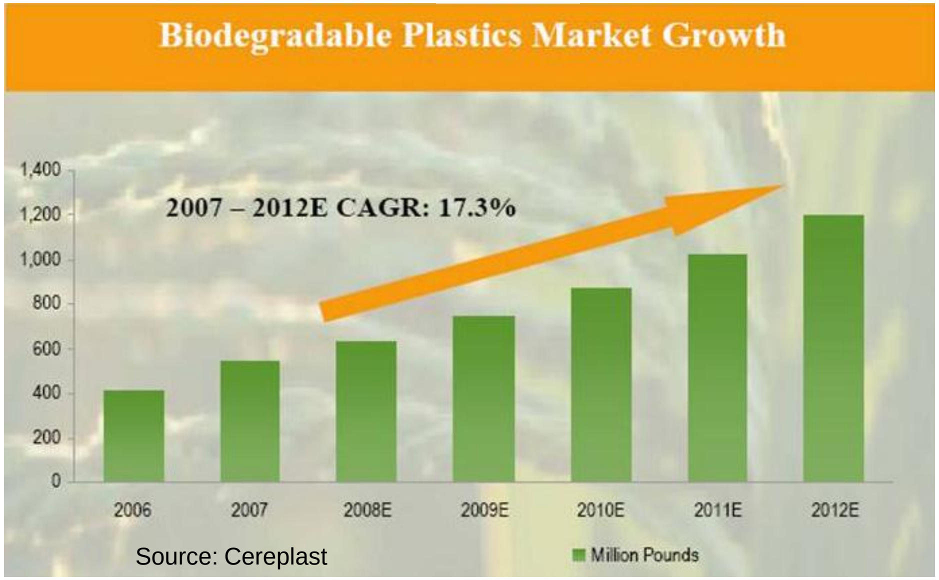
In its 'hybrid' products, Cereplast has targeted a 1% share of the fast-growing 55 million ton polypropylene market, which it estimates has annual sales value of more than $1 million. Bio-degradable plastics market growth in the U.S. is projected at an compound annual growth rate (CAGR) of more than 17% per year (Chart 8).

Lignin's Potential in Carbon Fibres (CF)

Carbon fibre is a material made of extremely thin fibres. It has high tensile strength, low weight, and low thermal expansion (Wikipedia). These attributes make it popular in aerospace, civil engineering, the military and sports.

At present, CF is expensive compared with fibreglass and plastic. Lignin is a cheap, readily available and renewable material which could be used to make carbon fibres.

Chart 8



Source: Cereplast

3. Injection Moulding and Extrusion Technologies

In this report, lignin fibre (or 'liquid wood') is being considered for its potential as a green building material in Alberta's window and door industry. The province has a significant petro-chemical base and petro-based plastics industry. It also has a growing plastics forming industry, using the major manufacturing technologies – injection molding and extrusion. These technologies are explained briefly below. Both would be important to developing Alberta's window and door industry if it began to use lignin fibre composites.

Injection Molding

This manufacturing process uses a combination of thermoplastic and thermosetting plastic materials. Thermoplastics and thermosetting plastics are polymers that turn to a liquid when heated, and are easy to mould and shape. They revert to a solid state when cooled, irreversibly in some cases. Thermoplastics are widely used in an extensive range of applications, and are well-suited for mass production of standardized components. For example, they are used to produce kitchen cabinets and tables. They are inexpensive, but are prone to scratching and eventual discoloration. Thermoplastics also are used for manufacturing car body panels. In the moulding process, the material is fed into a heated cylinder, mixed and pressure forced into a mould (Chart 9). The key feature of injection moulding is that it takes the shape of the die (i.e. it is similar to a 'pressed' panel or part).

Extrusion

This process is used to produce components that have a fixed cross-sectional profile. Unlike a moulding, the material is pressed through, or drawn through, a die that has a fixed cross section.

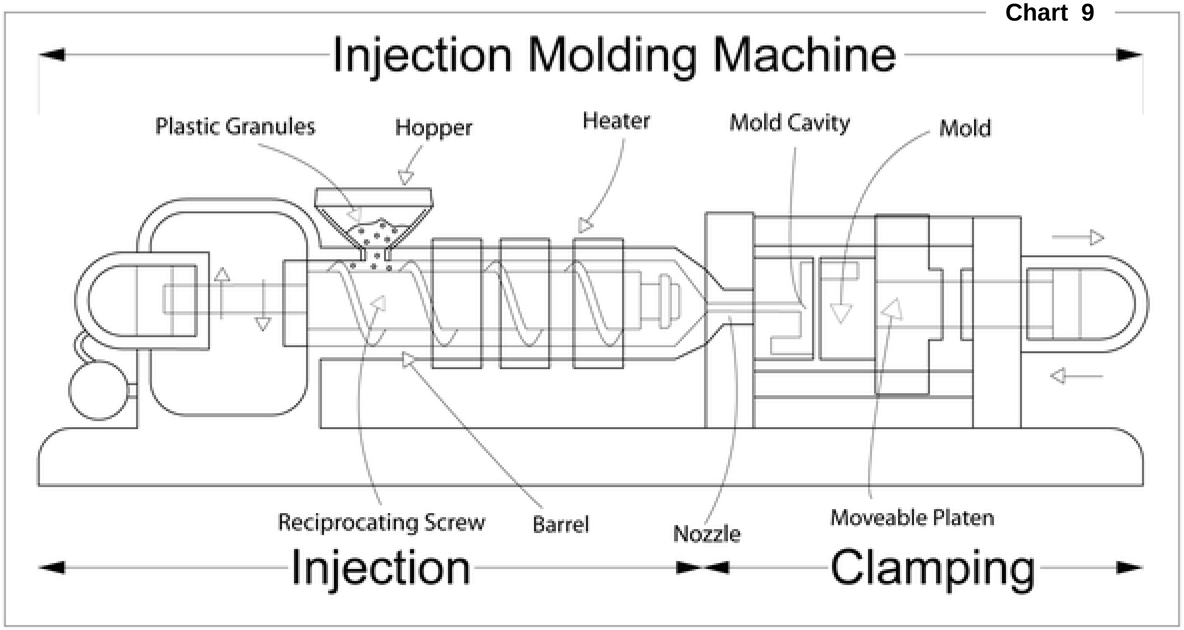
Extrusion technologies can use a variety of materials ranging from plastics (where they are heated) to metals, food – and potentially, liquid wood.

The main advantages of the extrusion process over other manufacturing processes are its ability to create complex cross-sections and work materials that are brittle. This is because during manufacture the material encounters only compressive and shear stresses. It also forms finished parts with an excellent surface finish (Wikipedia).

Extrusion may be continuous (theoretically producing indefinitely long material) or semi-continuous (producing many pieces). The extrusion process can be done with the material hot or cold.

Extrusion produces items such as pipe and tubing, weather stripping, window frames (e.g. aluminum) and wire insulation. Either major forming process can handle lignin fibre composites, but extrusion is best suited to the lignin composite window industry – in part because of flexibility of length of the extruded part and the ability of the process to adjust to different widths of the sill, head and jambs, and produce nailing flanges for fitting units into rough openings.

Chart 9



Source: Wikipedia http://en.wikipedia.org/wiki/Injection_molding

4. Why Are Lignin Composites Being Considered for Investment in Alberta?

There are many reasons that lignin composites are being considered by Alberta Finance and Enterprise (AFE) as a potentially significant investment prospect for Alberta. They include the following:

- Alberta is actively developing various 'green' industries as future potential growth sectors for the economy.
- The province has an extensive forested area (it has the 4th highest timber harvest in Canada), and could be a competitively priced source of lignin.
- It has a well developed pulping industry. Some of these mills (notably those falling below today's economy of scale) may be willing to consider lignin production as a supplementary source of income. The principal 'competition' in these cases would be bio-fuels (consumed either internally, or as a revenue source from feed-into-the-grid green electricity).
- Window and door manufacturing is one of the more important 'value added ' wood processing industries in the province. As a potential producer of 'green' windows and doors, Alberta could anticipate a sizeable expansion of this manufacturing sector which, with considerable export market potential, could (a) survive better against large scale U.S. producers (who have been capturing market share in Alberta – see later in this report) and (b) not be constrained by the limited size of the Alberta market.
- In addition, with a competitively positioned lignin composites industry, it may be possible for manufacturers in Alberta to partner with other Canadian firms (e.g. Loewen Windows in Manitoba) to develop new 'green building' product lines for the Canadian and export markets.
- There are numerous other industries which could be developed, or expanded, using lignin pellets and/or lignin composites based on extrusion or injection moulding equipment which already exists within the province's oil-based plastics industry.
- There are strong potential linkages between Alberta's pulp industry and its agricultural industry in the production of natural fibres which could form the basis of a world scale bio-plastics industry (e.g. lignin along with finely-ground wood fibres – and agricultural crop fibres including the bast of industrial hemp [one of the longest length natural fibres available, and ideally suited to applications where bio-plastic strength is important]; flax and wheat straw. Natural wax is an excellent binder in pellets.
- Bio-plastics producers in Alberta could partner with oil-based plastics producers to produce 'green' 'hybrid' plastics which could be distributed by the already well developed oil-based plastic industry. In this context, the Californian Cereplast business model (see previous pages) is worthwhile considering for Alberta.

Technical *and* Strategic Reasons for Lignin Composites

Pure lignin in liquid form is highly viscous. It can be used to produce a wide range of bio-plastics through injection moulding technologies (e.g. building panels). By combining lignin with other natural polymers and natural fibres, however, its range of extruded products potentially is very wide. These other compounds also provide more scope for pure lignin (or ''liquid wood') to be designed and engineered to develop desired characteristics.

This is important because there are two primary development strategies available to bio-plastics producers. Firstly, they can work to carve-out new product niches in emerging 'green markets' and eventually hope to develop these to large volume markets. Secondly, they can 'target' various oil-based plastic market segments (e.g. polypropylenes) and try to displace them. In the latter case, collaboration with already well-established and well-capitalized oil-based plastics producers could yield potentially mutual benefits.

5. Existing Producers of Lignin Fibres in Alberta

Existing Capacity – Forest Industry

Alberta's forest industry is a substantial producer of lignin fibres. Much of this is produced as a 'by-product' of the chemical (kraft) pulping process, and is further processed to recover process chemicals and produce bio-fuels. An additional very substantial part of the 'lignin potential' produced by the industry remains 'trapped ' in solid wood products, and is not considered within this report. Conceptually, however, if 100% of the province's allowable annual cut of coniferous and non-coniferous wood were to be processed for lignin extraction (highly unlikely), it would yield an estimated 1.4 million tonnes*** of 'pure lignin'. This is a massive volume, and would position Alberta as a major global supplier of this natural 'green' product.

Alberta has four chemical pulp mills (northern bleached softwood kraft [NBSK] and/or hardwood kraft [NBHP] pulp) and three mechanical pulp mills – one of which is integrated into newsprint production (Chart 10). The latter mills do not produce lignin in their processing. Based on the actual volume of lignin produced as a 'by-product' of the kraft pulping process at the four chemical mills in 2007, the industry had a theoretical total output of 290,000 tonnes of 'pure lignin' equivalent. As noted, lignin is not extracted in its pure form as yet within Alberta. Comparatively only small volumes are produced within the Canadian pulp and paper industry, except for Tembec – which is a supplier of lignosulfonates, used as a concrete additive.

As a point of comparison, the potential of Alberta – based on actual 2007 production of 'lignin-in-process' at already existing pulp mills within the province – is well in excess of one thousand times the projected output of the Tecnaro lignin pilot plant (275 tonnes annual capacity, planned for 2010) designed to produce 'Arboform' (see separate page). Also as a comparison, the CEREPLAST bio-plastic plant in California (which uses starch) has an initial annual output capacity of around 25,000 tonnes. It can be concluded that a more than adequate supply of lignin conceptually already is available from existing processing facilities within Alberta's pulp and paper industry to support a lignin 'liquid plastic' industry in the province.

Agricultural Industry

In addition, the province's agricultural industry produces a vast array of cellulosic fibres, many of which contain significant proportions of extractable lignin. This extraction is not done today, however. The product-market section of this report identifies several potential applications for various grades of lignin that could be produced at a stand-alone 'liquid plastic' plant in Alberta.

Among these applications, various grades of cellulosic fibre available from the natural resource industries also can be included in products such as asphalt for roads. This would be a possible 'green' alternative to petroleum based asphalts widely used today in Alberta, but technical issues need to be addressed.

Alberta's Forest Industry **Chart 10**

Lignin producing NBK mills include Hinton, Grande Prairie, Daishowa-Marubeni and ALPAC.

*** based on AAC of 27.1 million m3; 4.75m3 of green fibre per ADMT of input fibre and a 'pure lignin' content averaging 25%.

5. Existing Producers of Lignin Fibres in Alberta

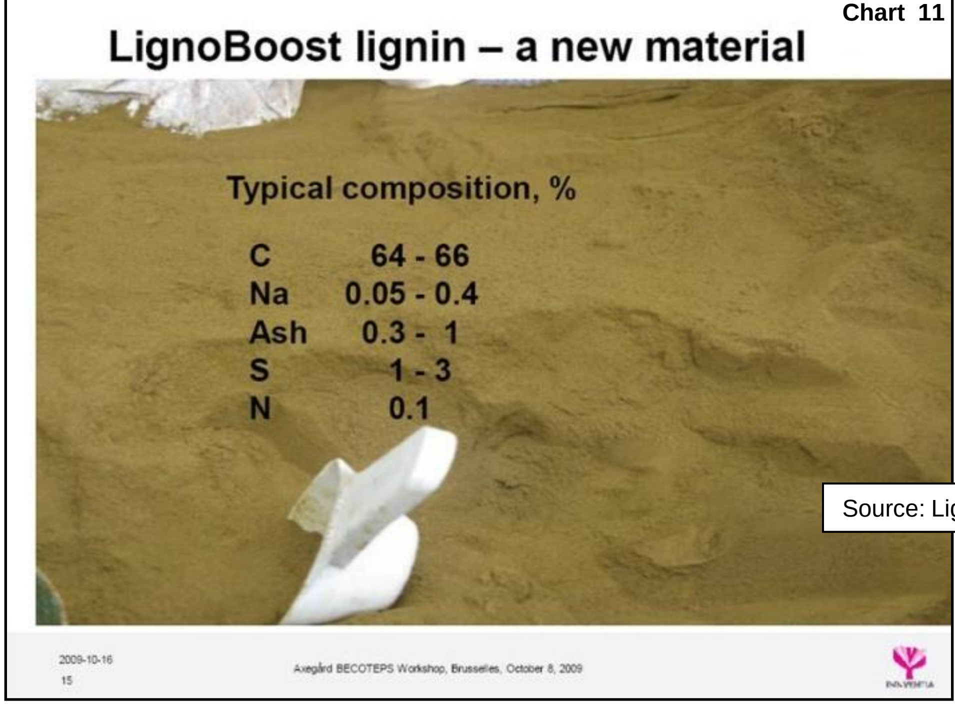
Chemicals Pulp Mills: The Lignin Extraction Process

Like many other pulp and paper producing regions, Alberta has two types of pulp mills. Chemical pulps mills use the kraft pulping process. They process Alberta's hardwoods (aspen-poplar) and softwoods (spruce-pine-fir chips) to make market pulps primarily for export. The yield on fibre is about 50% because the kraft process (see below) dissolves the lignin and hemi-cellulose fractions – leaving the almost pure cellulose pulp component subsequently to be bleached, washed and dried prior to shipment.

In mechanical pulping, almost all (~95%) of the fibre is carried through the pulping process and forms part of the final product. In Alberta, this is either market mechanical pulp (bleached CTMP) or the pulp is integrated into papermaking (i.e. newsprint). The province's mechanical pulp mills can be disregarded for the purpose of this report.

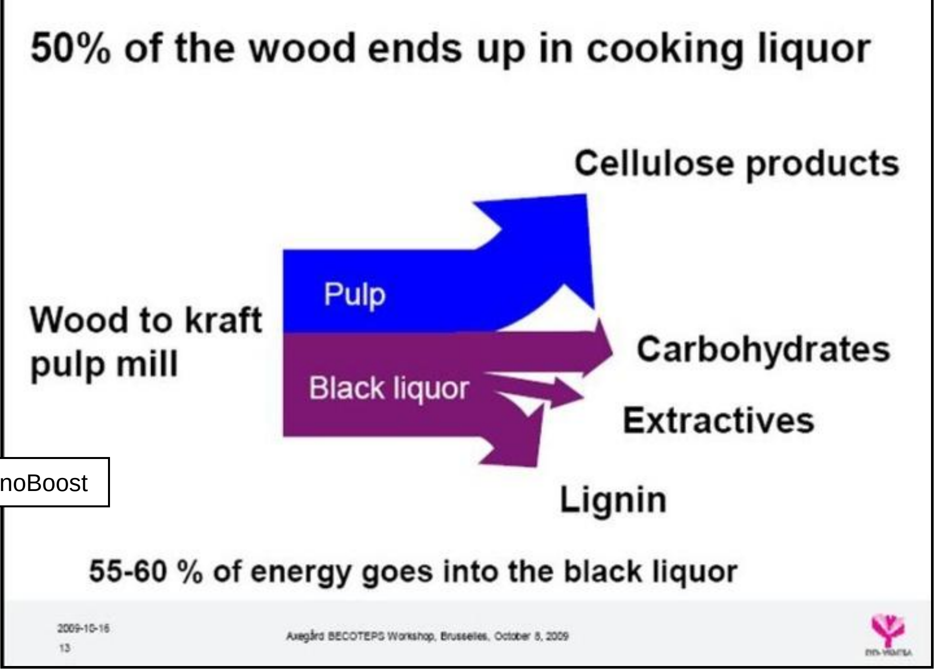
The kraft pulping process, which potentially can produce very pure powdered lignin (see LignoBoost process, Chart 11), is illustrated in Chart 12. Lignin production, as a distinct business for the pulpmill, would involve diverting the black liquor stream to lignin recovery – rather than to be burned to recover pulping chemicals and to produce part of the steam/energy (40% to 50%) needed for papermaking, as at present.

Chart 11



Source: LignoBoost

Chart 12



6. Existing Global Producers of Lignin and Lignosulfonates

A well developed supply chain and market exists for lignosulfonates, which are water soluble compounds produce by the sulphite chemical pulping process (a distinct, but allied process to the kraft pulping process). Moreover, many firms – including Tembec in Canada (Chart 13) – are established as suppliers of lignosulfonates and kraft lignin chemicals (Chart 14).

Although it is a distinct pulping process, some of the end-use markets for lignin that can be produced as a distinct by-product of the kraft process are the same as those for lignosulfonates. This is important because, as already noted, the oil-based plastics industry already is open to the displacement of some of its oil-based feedstock by bio-chemicals and bio-plastics. The motivation is the rapidly emerging 'green market' for hybrid plastics.

Except for soybeans plastics, most current sources of existing bio-plastics are reported to be 2 times to 5 times more costly than oil-based plastics. There is considerable interest in developing lower cost supplies of natural feedstocks (Chart 15) among which lignin has considerable potential. At a reported price of around 10 cents per lb for **lignin feedstock** (data source: Ontario Auto Council), lignin could be price competitive with oil-based **commodity plastics** priced at 90 to 100 cents per lb.

Chart 15

Low Cost Biomaterials

Petrochemical commodity plastics ~ 90 to 100 cents / lb. Except for soybased plastics, most bioplastics are 2x – 5x more expensive than petrochemical plastics.

Hemp	~ 15+ cents / lb
Lignin	~ 10 cents
Soy meal	~ 10 cents
Wood flour	~ 6 – 10 cents
DDGs	~ 5 cents
Glycerol	~ 5 cents
Wheat Straw	~ 3 cents
Corn Stover	~ 3 cents
CO_2 (from fermentation process)	~ 0 cents

ONTARIO BIOAUTO COUNCIL

Chart 13

Major Lignosulfonate Producers

Producer	Country	Annual Capacity
Borregaard LignoTech	Norway	160,000
LignoTech Sweden	Sweden	60,000
Borregaard Germany	Germany	50,000
LignoTech Iberia	Spain	30,000
LignoTech Finland	Finland	20,000
LignoTech USA	United States	60,000
Georgia-Pacific	United States	200,000
Westvaco	United States	60,000
Fraser Paper	United States	60,000
Tembec	Canada	35,000
Avebene	France	40,000
Tolmezzo	Italy	30,000
Sanyo Lolusaka	Japan	50,000
Others		150,000
		1,005,000

Based on Lignin: Historical Biological and Materials Perspectives-J. D. Gargulak and S.E. Lebo, 2000 ACS

Chart 14

Kraft Lignin Chemicals

Phenol-Formaldehyde Resin

Antioxidant Rubber Filler

Asphalt Emulsion

Source: Magdzinski. Performance Development Associates (July 2006)

7. Markets for Lignin ('Liquid Wood') and Lignosulfonates

End-Use Applications and Market Growth

To be able to penetrate the extensive global and North American market and displace vinyl (PVC or uPVC) as a natural 'green' products in windows, along with other PVC products such sidings, fascia and weatherboarding, lignin composites would have to replicate the performance characteristics of vinyl/PVC. These types of issues are technical in nature, and would require R&D follow-up (Chart 16).

Existing markets for lignin chemicals, as already noted, are well developed (Chart 17). Moreover, projections indicate that modest growth is taking place in demand for these products. Chart > provides an estimate of the existing global lignin market (source Tembec) and shows that the global market is between 1 million and 1.,1 million tonnes per year. The annual rate of growth (CAGR) is around 2% annually. A much higher rate of 'adoption' of lignin presumably would be required to attract investors.

Lignin used in bio-plastics has the potential to displace several oil-based plastics. In vinyl/PVC, which is the dominant plastic used in windows, there are substantial concerns about its health and safety aspects. Japanese car makers have eliminated vinyl/PVC use in the interior of their vehicles. Lignin composites would have to perform well to be considered as a replacement material for major industries of this type.

Chart 16

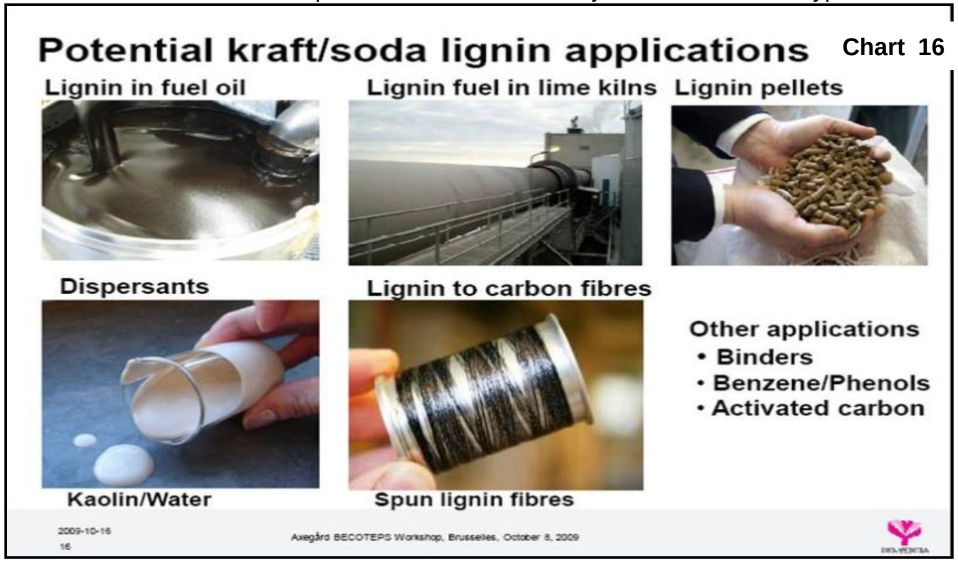
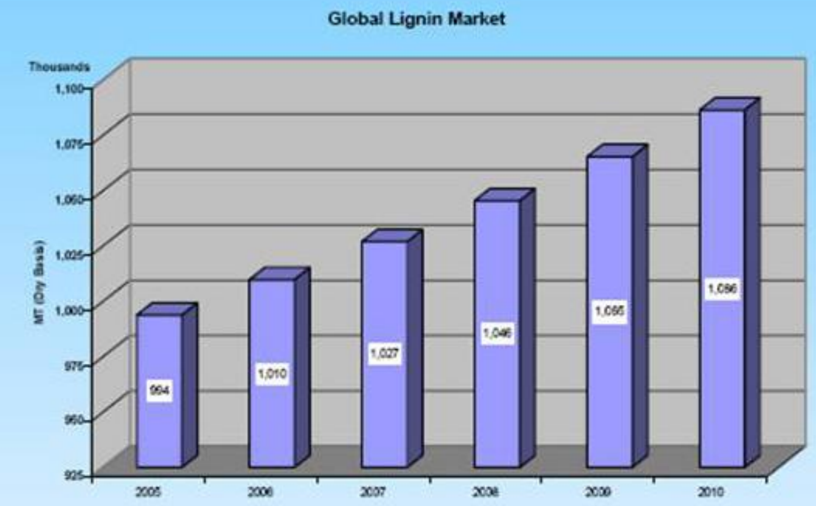
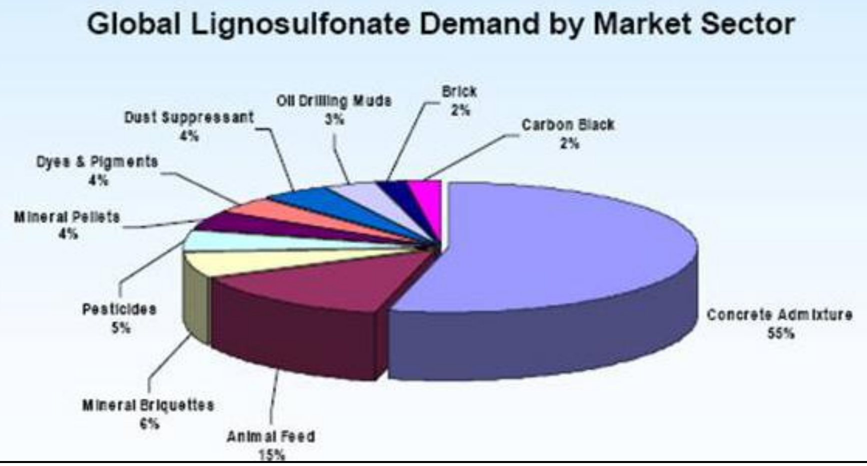


Chart 17





7. Markets for Lignin ('Liquid Wood') and Lignosulfonates

Lignin Production in Alberta: Need for Multiple Markets

As the analysis on the next several pages demonstrates, the window and door industry in Alberta is not currently of sufficient scale – nor is it sufficiently developed – to warrant a dedicated program of lignin production at a local pulp mill, as envisaged as a possibility by AFE. However, in addition to its window and door industry, several other of the province's manufacturing sectors could represent potentially significant markets in aggregate. These other sectors (which also include those which produce and use agricultural fibres) could combine forces to produce lignin composite parts for Canada's auto industry, based primarily in Ontario.

For potential producers of lignin composites in Alberta, the key to gaining market share and growth opportunities would be to gain market share also from other existing and well established industries. The auto sector currently uses many oil-based plastics, but is committed to phasing-out the use of some oil-based plastics either for financial reasons (e.g. rising costs of polypropylene) and/ to develop a higher 'green' content in its products.

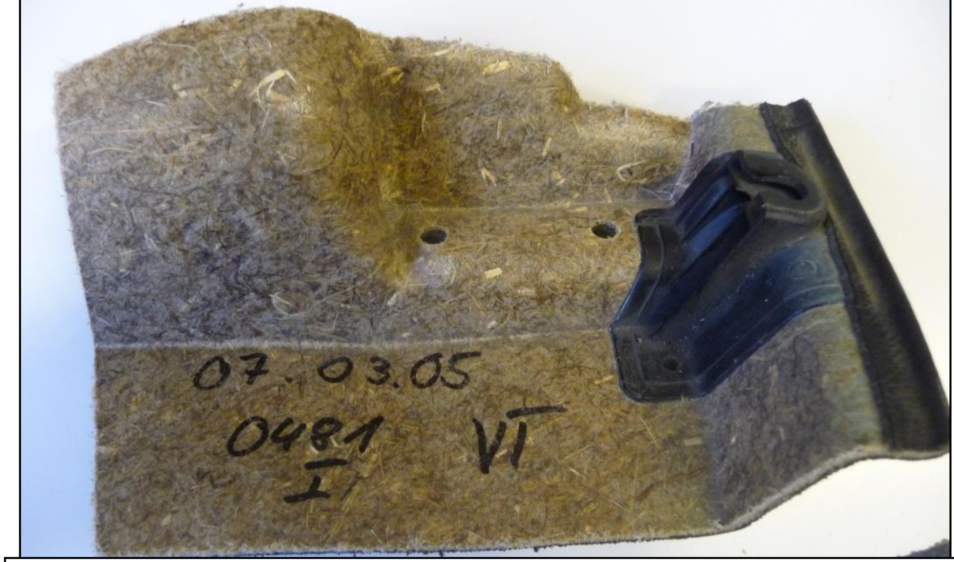
Lignin and lignin composites could be candidates to displace some oil-based plastics in this sector. Together with other sectors, these might form sufficient 'critical mass' to justify an economy of scale lignin production program and lignin composites production within Alberta.

Automotive components containing renewable raw materials (including hemp, flax and abaca) are one of the most rapidly growing markets for high density hemp composite boards. It is estimated that over 26 components of this type are being used in, for example, the current Mercedes-A Class compact vehicle (Chart 18, information source: Daimler Chrysler Research Unit).

Other auto manufacturers using natural fibre composites to replace fibreglass and other materials in interior panels, dashboards, trunk liners and trim (Chart 19). They include BMW, Volvo and Fiat-Renault. The Opal Astra (General Motors) uses flax felt mats. Flax also is used for headliners and rear parcel shelves used for the Renault Twingo. Toyota uses ecological plastics in its hybrid Prius model and aims for them to be used in up to 60% of a car's interior components. China's automotive industry also is using components with a natural fibre base (source: ATA- Journal for Asia on Textile and Apparel).

In North America, Ford will be including 20% wheat straw bio-filler along with polypropylene in selected interior components starting with the 2010 model Ford Flex . As with all products displacing existing proven ones, the new materials and hybrids have to pass technical performance tests as well as commercial tests of acceptance.

Molded car panel using industrial hemp fibres Chart 19



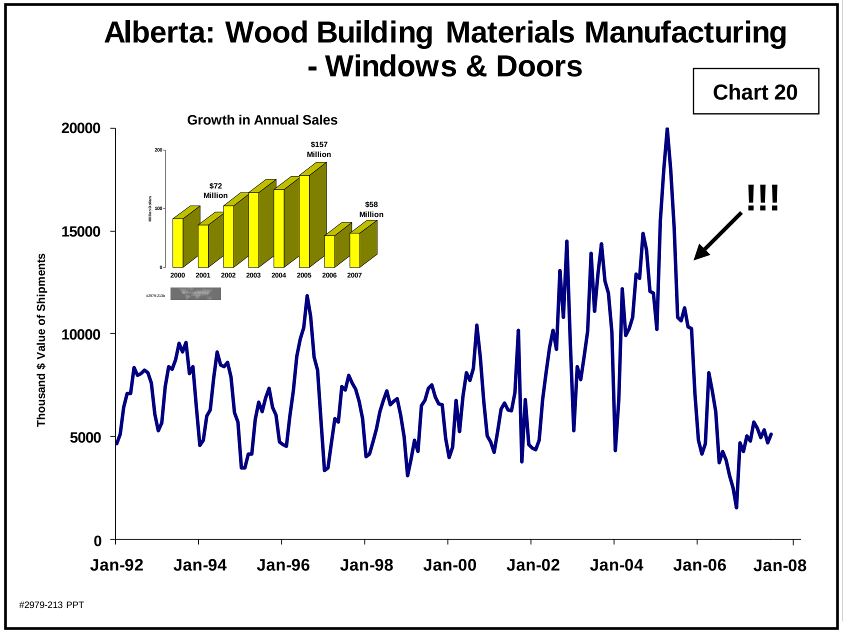
In France, AFT Plasturgie (located at Dijon) produces composite materials (typically 50% polypropylene) reinforced with hemp fibres (50%). Most of its 6,000 tonne annual capacity goes into the European automotive sector. Source: ATA

8. Alberta's Window and Door Industry -Today

Window frames and sashes can be made of aluminum, wood, a combination of wood and vinyl or aluminum, or solid vinyl. Industry Canada (www.ic.gc.ca) data indicate that, in 2008, Alberta had 70 window and door manufacturing firms. Of these 46 were primarily producing metal windows while 24 were manufacturers of wood windows, including vinyl/PVC products. Most of these were small to medium sized firms, but none were as large as the U.S. giants (see below) who dominate the North American commodity window and doors industry. There were 12 firms operating in Alberta whose size is described by Industry Canada as 'micro' (i.e. 1-4 employees). The majority (43) were classified as 'small firms' (5-99 employees) while 5 were classified as medium scale (100-500 employees). Some of the window and door manufacturing firms operating in Alberta have developed a market niche, several of which serve high end, quality custom markets. Others serve mainly commodity markets (Chart 21).

After growing rapidly in revenues for much of the early 2000s (Chart 20), the Alberta wood windows and doors industry suffered a sharp setback in sales starting in 2006 – despite the fact that housing starts within the province continuing to grow rapidly (see next page). The reason was that large scale U.S. window and door manufacturing 'giants' (including Marvin, Andersen, Pella and Jayman) were able to win significant market share very quickly within Alberta – displacing local producers. There were several reasons. U.S. large scale firms have lower unit costs. With sharply reduced US demand, they were attracted by Alberta's booming economy (Oilsands spending and large projects) and they had a sharply reduced exchange rate disadvantage as Canada's currency strengthened.

It is a vulnerability in this manufacturing sector that Alberta will have to try to overcome by developing other competitive strengths (next page).



Commodity windows and doors in a Calgary sub-division

8. Alberta's Window and Door Industry –The Future

Sector Under Threat: Potential for New Business Models

In business, to assure its long term survival and prosperity, sometimes the best thing to happen to an industry is to experience a sharp loss of market share and competitiveness. Often it forces investors and manufacturers to 're-think their business' and sometimes this process results in a more adaptive, increasingly competitive new business model. For Alberta's window and door industry, this is particularly important – and urgent. The industry has built up enough capacity, along with net imports, to serve the needs of recent peak new housing starts of nearly 49,000 units annually (2006 peak, followed by 48,000 units in 2007). The industry also has the capacity, again with net imports from the U.S. to meet the needs of non-residential, commercial and industrial markets boosted by peak Oilsands spending in 2007. The third market segment served by the industry, home improvement, also has sufficient capacity to meet 2007 peak home improvement spending needs.

Our analyses and projections assume that Oilsands spending in Alberta eventually will return to past peak levels. In addition, home improvement spending in the province likely will recover to previous peak levels within a few years – helped by temporary stimulus programs such as the Home Renovation Tax Credit ('HRTC'). This boost in spending over today's levels will help the province's metal and wood window door industry to recover financially.

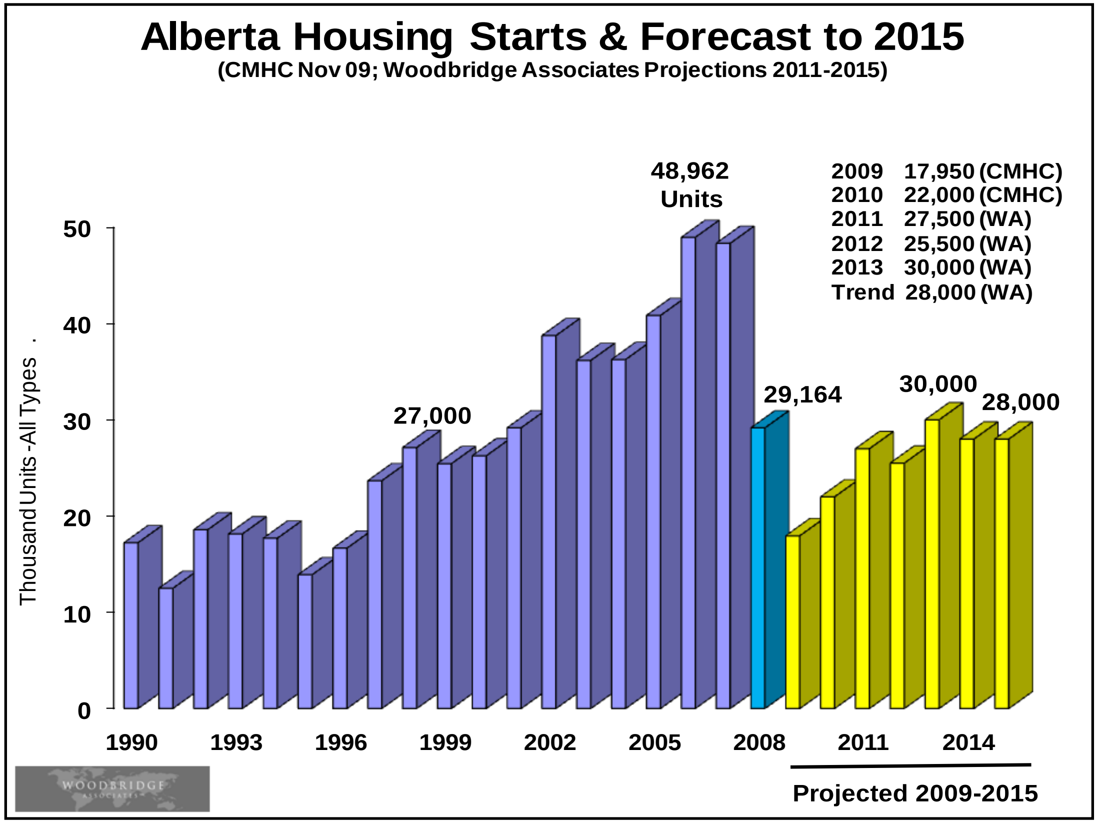
However, as already noted, U.S. 'giants' will compete aggressively for the non-residential and residential business as the recovery occurs. With the prospect of a strong Canadian dollar in U.S. funds, a return to the former 'golden days' for the industry does not appear to be in prospect.

In addition, new housing starts (Chart 22) are projected to recover from the approximately 18,000 unit level currently forecast by CMHC for 2009 and will vary within the 25,000 to 30,000 unit range annually for most of the next five years and beyond, in our view. Moreover, part of this is multi-family unit residential housing demand – using fewer windows and doors than single family units.

New Thinking
Our analysis concludes that Alberta wood and metal window and doors sector are under competitive threat currently, and for the foreseeable future (year 2015, and probably beyond). Although business conditions will improve, the industry still operates or has idled much of the manufacturing capacity suited to previous peak demand levels.

With potential growth in 'green' window and door products (possibly being supplied from other supply regions (eastern Canada and the U.S.) new thinking (see examples, next page) will be required for long term prosperity of Alberta's window and door manufacturing sector.

Chart 22



9. Alberta's Window and Door Industry –The Future

New Thinking (continued)

The sources through which Alberta's window and door sector potentially could develop a competitive edge include the following:

1. Scale (lower unit costs)
2. Technology
3. Market Niche
4. New Investment

Increased scale typically brings opportunities for significant productivity gains through the use of state-of-the-art equipment. When operated at capacity, this helps to drive unit costs of production lower and improves overall financial performance and competitive positioning. Significant rationalization of the industry within Alberta (reducing substantially the number of players in the industry) could occur – but is unlikely to be sustained because there are few barriers to the entry of new players. This means that, for firms seeking a competitive edge, there are two fundamental strategies. They are the use of technology and the development of market niches. They are complementary –and can enhance each other. One example of a technological edge in the commercial industrial sector is for metal window producers in Alberta to manufacture 'curtain windows' versus the conventional wall windows currently used.

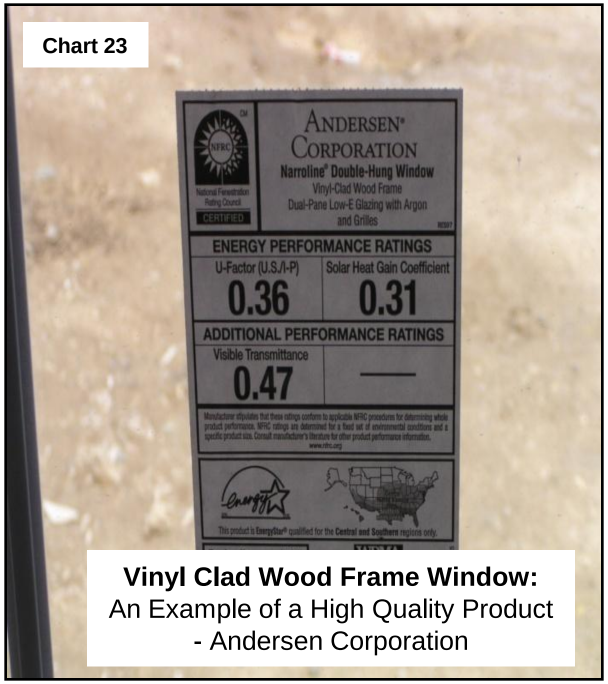
Another possibility is to combine a new technology, such as the lignin fibre composites investment opportunity outlined in this report, with an emerging market niche, such as the market for 'green' windows and doors.

In our view, scale (and therefore lower costs, potentially) can be achieved if items 2, 3 and 4 above are successful. Items 2 and 3 could be the initial drivers.

Lignin fibre composite technology use in the North American window and door industry is not yet developed, and may still only be at the conceptual or pilot plant stage. Globally, it may be the same situation. This means that leadership in this field is still open for 'first movers'. In this report we have demonstrated that Alberta possesses an adequate supply of raw materials and has pulp mills that already have the capacity and potential motivation to consider producing lignin in significant commercial volumes (see early sections).

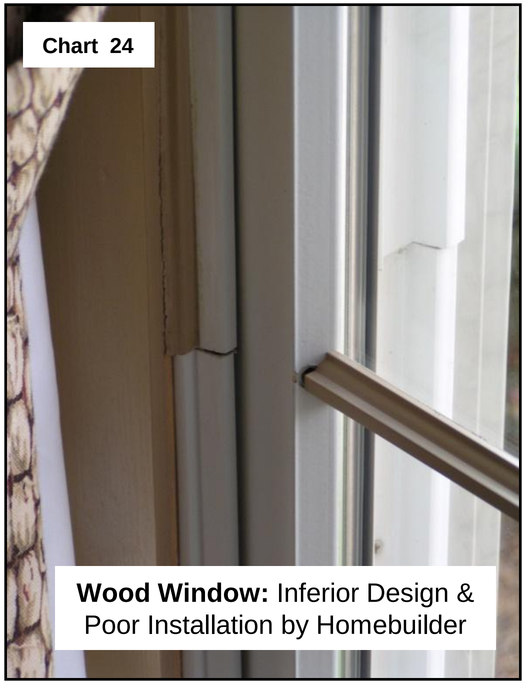
We also note that a lignin fibre composites industry needs to develop within the province. Moreover, we have concluded that that Alberta's windows and doors manufacturing sector alone is a useful, but not sufficient market, to absorb the large scale of lignin production and lignin fibre composites that would be necessary. But, in combination with other industries, sufficient demand could be developed.

Chart 23



Vinyl Clad Wood Frame Window: An Example of a High Quality Product - Andersen Corporation

Chart 24



Wood Window: Inferior Design & Poor Installation by Homebuilder

9. Alberta's Window and Door Industry –The Future

New Thinking (continued)

The fact that no firm or region has yet staked out a leadership position in green-built windows and doors should be encouraging to Alberta policy makers – and to potential investors in green technologies and manufacturing. Innovative green technology based windows and doors, manufactured in Alberta, could make significant inroads into the Canadian domestic market and in the U.S. market. This is because manufacturers of oil-based products (e.g. vinyl/PVC windows and siding) are vulnerable to market share loss on several counts. Their feedstock prices are high and likely to remain so (global oil prices) and there are health and fire risk issues related to some plastics, such as vinyl/PVC. These are well documented.

Chart 23 on the previous page suggests that U.S. industry 'giants' are high quality producers and likely to remain dominant in commodity products. But Chart 24 shows that there is substantial scope for niche players to improve the quality of product provided, and help ensure quality installation. North American demand will recover, and a substantial market exists both in new housing (Charts 25-26) and in the home improvement market (Chart 27). 'Green' products likely will capture a growing share.

Chart 27
Photo: Woodbridge Associates


Chart 25
Photo: Woodbridge Associates


Chart 26
Photo: Woodbridge Associates

10. Lignin Fibre Composites Investment Opportunity: Next Steps

One of the key next steps for Alberta, in exploring and further evaluating the potential opportunity for lignin fibre composites, is to bring together key players who stand to lose from current trends and/or benefit from emerging trends. Clearly, Alberta's wood pulp industry is one of these players. Another is the province's window and door manufactures. Installers are a potentially interested group. So are distributors. Importantly, the oil-based plastics industry should be key participants – as should Alberta's agricultural industry as potential providers of fibre for lignin fibre composites. The Alberta Research Council (ARC) has an important R&D role.

Finally, key end-users – such as the auto sector –which already are moving in this direction should be early participants, as this is where much of the money exists that potentially could flow into this emerging sector.

The dialogue among these players needs to be 'roundtable' in nature. Not all participants will come to the table with a well developed concept of the potential (e.g. Chart 28). Nor will they necessarily agree initially on basic assumptions or on the prospects for this technology.

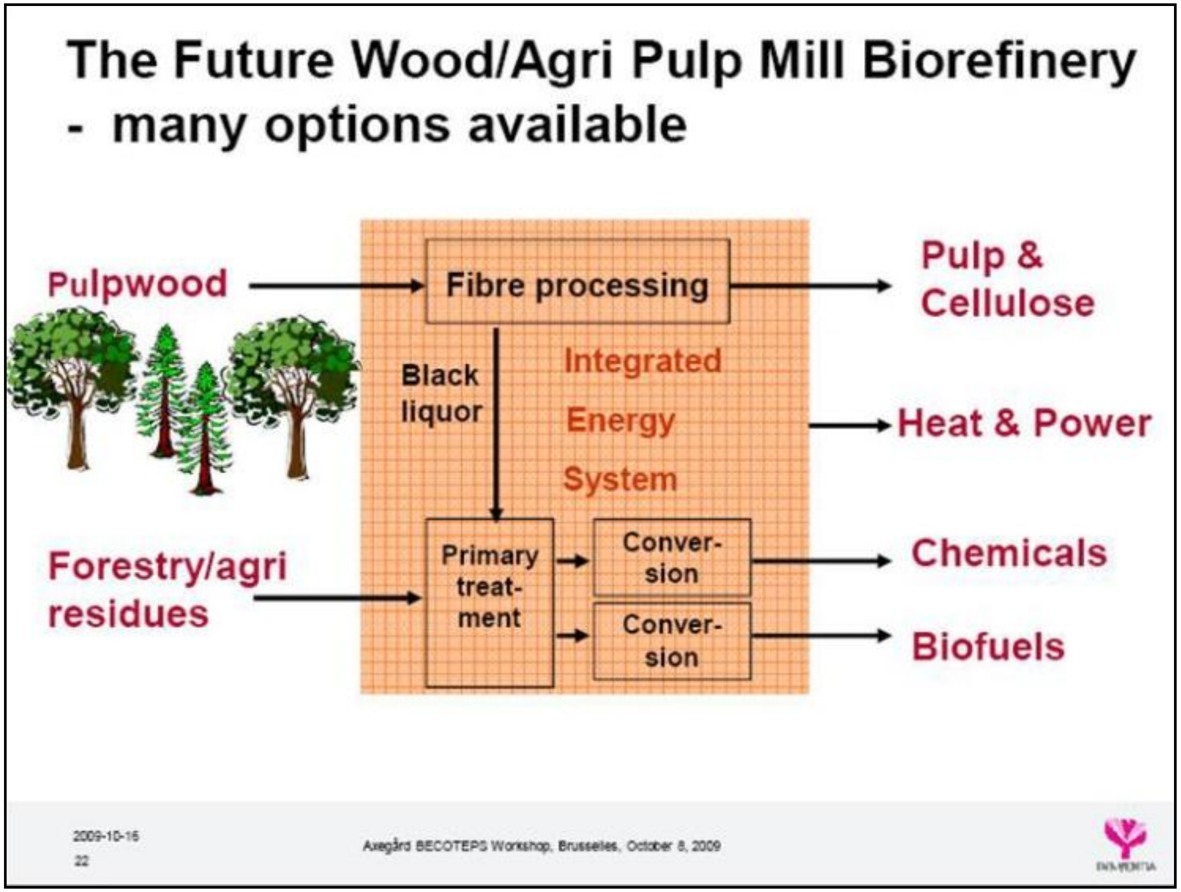
Preliminary steps in R&D may need to be developed.

Recent global macro-economic events have substantially shaken the confidence of all industry executives and managers. The positive 'take-away' from these global events is that they are forcing a fundamental re-thinking of basic assumptions. An enhanced level of willingness to be creative and innovative is one of the results.

As Alberta's economy becomes more diversified from its heavy oil, gas and petro-chemical base – and as the province addresses carbon capture and storage opportunities – 'green built' construction approaches and the use of innovative 'green' building materials will become increasingly important.

Much more work needs to be done for the investment potential identified in this report to become a reality. Even so, it appears that at this stage lignin fibre composites could address several issues within the province –and could become a substantial and sustainable 'green' growth industry for Alberta.

Chart 28



For Further Information Regarding the Potential Investment Opportunity Presented in this Report, Please Contact:

Alberta Finance and Enterprise

Contact Details to be Added