

Hemp Insulation and Hemp Board

Commercial Opportunities for Alberta Producers BUSINESS CASE

Final Report

Prepared for Alberta Agriculture and Rural Development (ARD); Alberta
Finance and Enterprise (AFE) and the Alberta Research Council (ARC)

July 2009

Letter of Transmittal

July 31st 2009

Lori-Jo Graham
Project Manager
Green Building Material Team
Opportunity Assessment Branch
Alberta Agriculture & Rural Development
2nd floor, 50-5030 Street
Olds, Alberta
Canada T4H 1S1

Dear Lori-Jo,

FINAL REPORT

We are pleased to submit our Final Report on the market and commercial potential for industrial hemp grown in Alberta and which potentially could be processed into hemp insulation and hemp board products in the province.

The scope of our terms of reference did not cover industrial hemp products other than these two groups. As you will see from our conclusions, we believe that the better 'product prospect' of the two for Alberta farmers who may be considering growing industrial hemp would be hemp insulation. Hemp boards, we believe, would not be a good choice of end-markets because of the already extensive competing manufacturing capacity in existence, intense price competition and quality competition from North America's highly integrated non-structural panelboards industry (i.e. particleboards and MDF). On the other hand, hemp insulation, would target a vulnerable sector of North America's existing insulation industry – notably glass fibre – and, if industrial hemp is grown and processed at adequate scale, would offer a potentially price attractive green alternative to high GHG-emitting insulation materials currently on the market.

We appreciate the opportunity to carry out this assignment on behalf of Alberta Agriculture and Rural Development (ARD), Alberta Finance and Enterprise (AFE) and the Alberta Research Council (ARC) – and look forward to discussing our report with you and the Project Team at your convenience.

Yours Sincerely,

original signed

Peter Woodbridge
President

(604) 922 4090

pw@woodbridgeassociates.com

Executive Summary

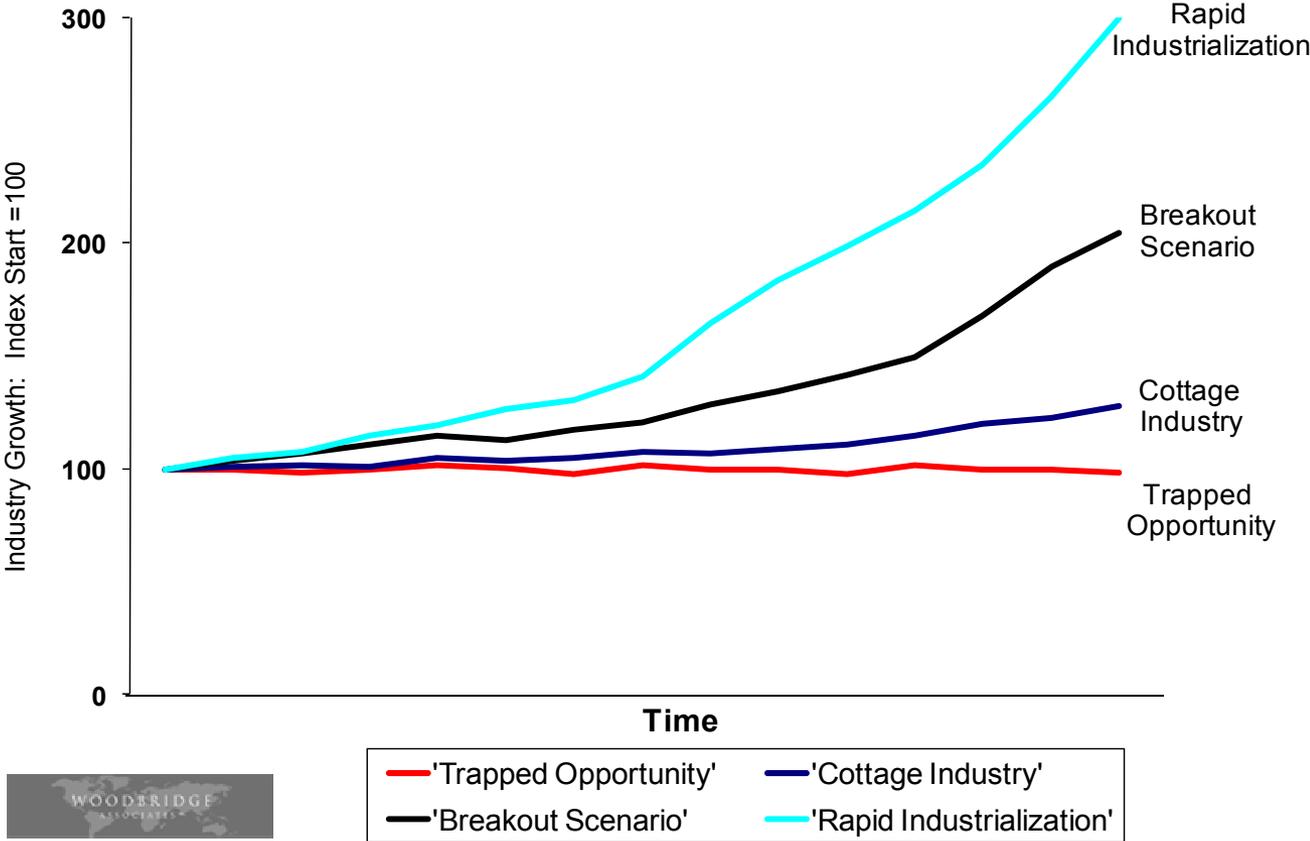
- The industrial hemp growing and processing industry globally is in its infancy. In Canada, the industry (in its modern form) has only a decade of history. The total area under licensed hemp cultivation is very limited – and peaked at 20,000 hectares in 2006. By 2008, it had declined to just over 3 thousand hectares. Over 90% of the crop is grown in western Canada – notably Manitoba. Alberta has produced 10% of Canada's output over the past decade – mostly focused on exports to the U.S. market (where growing is still banned). Two main industrial hemp products are produced – oilseeds for oil extraction and foodstuffs and strong long fibres for a variety of uses.
- Unlike major commodity crops, such as wheat and canola, there isn't a well-developed industrial hemp growing and processing industry. Nevertheless, industrial hemp has many attractions as a potential large scale crop, either as a break crop or under sustained production. It can produce very high crop yields. All of the plant can be utilized and it has an extensive number of high value and intermediate value end-uses. Importantly, it can be processed into very desirable benign and green building materials. Several useful business models used in Europe point to the growing and market potential of this crop in these applications.
- With the opportunity to tap into market opportunities created by rising concerns about greenhouse gases (GHGs) and the need for 'green' insulation and other building products, two industrial hemp products were evaluated in this report. They are hemp thermal insulation and hemp boards. Hemp insulation has significant potential as a replacement for GHG-intensive glass fibre insulation (51% of the thermal insulation markets in North America, which is growing by around 6% per year).
- We have identified the business case for hemp insulation to capture up to 5% of this market by 2013. Importantly, the raw materials supply for other cellulose 'green' insulation products is declining. However, hemp insulation will have a tough fight for market share against fibreglass and foamed plastics (SPFs) –and would have to be produced in state-of-the-art, large scale manufacturing facilities in order to achieve price competitiveness. There is potential for the construction of four (4) state-of-the-art hemp insulation manufacturing plants in North America over the next five years. They could be constructed in Alberta, helped by the potential for large scale growing operations within the province. Economies of scale, along with technical R&D support, are the keys to global competitiveness for Alberta.
- Although Manitoba is a larger grower of industrial hemp, and has a track record of trying to establish a processing facility, Alberta has an equal opportunity to grasp leadership in growing and processing this industrial fibre. Importantly, through its ability to offer R&D support to the hemp industry's development, the Alberta Research Council (ARC) could provide a unique competitive edge to Alberta in the large-scale commercialization of this crop. ARC could provide a vital link with large-scale channel partners and end-user investors and potential customers in the building materials industry and the automotive sector.
- Strategically, although growing of industrial hemp currently is banned in the United States, the development of large scale, high productivity industry in Alberta could achieve a global low unit cost position that would be vital in case this ban is ever lifted. U.S. farmers also could grow industrial hemp, if permitted to do so, but with globally low unit costs of production –and a head-start in developing growing , crop processing and possibly end-product manufacturing, Alberta's competitive position would remain high.
- With regard to the business case for the second product investigated in this report – low and medium density hemp fibreboards – we are far less optimistic. Moreover, we recommend that this potential product opportunity should not be acted upon. It could be re-visited within the next five years or so, by which time we anticipate that residual wood fibres used in the dominant U.S. \$9 billion/y particleboard and medium density fibreboard (MDF) will become more scarce and expensive. In time, the long strong fibres that are a key distinguishing property of industrial hemp could become very valuable as reinforcing fibres for established board producers.
- We have, however, identified an immediate opportunity for the production within Alberta of high grade fibres and/or high density fibreboards for use in the automotive sector. Hemp fibres would be used in conjunction with thermo-plastics. Other fibre products would have to be produced to make this economic. ARC could play a key role.
- At the policy level, we have identified four possible development scenarios for industrial hemp development in Alberta. These are illustrated in Exhibit A on the next page. Our business case evaluations point to significant potential benefits for growers in Alberta, and new investment and job creation potential in 'green' manufacturing.

Executive Summary (continued)

Industrial Hemp: Alberta Industry Development Scenarios

Exhibit A

Conceptual: For Illustration Purposes Only



In our view, the current probabilities for a successful industrial hemp industry in Alberta are a 70% likelihood of somewhere between a 'cottage industry' and 'breakout' path of development.

However, with the prospect of being able to capture up to 5% of the predicted U.S.\$12.8 Billion thermal insulation market in North American by 2015, Alberta could spearhead a 'Rapid Industrialization' phase for industrial hemp growers.

Demand for energy efficient, and net zero (and low or zero-GHG) raw materials used in building structures, is being encouraged by tax-incentives. As a benign, natural fibre, industrial hemp offers some unique advantages as a replacement for less desirable existing products.

A 'Rapid Industrialization' phase for industrial hemp also could be achieved if large scale users such as the automotive industry in North America "buy-in" to the fibre's potential –as they have in Europe.



Table of Contents

	Page
<i>Letter of Transmittal</i>	2
<i>Executive Summary</i>	3
<i>Table of Contents</i>	5
1. Purpose and Scope of Report, Methodology and Acknowledgements	6
2. Emerging Markets for Ecologically-Friendly Building Products	7
3. Product Development & Commercialization Goals in Alberta: Producers' Perspective	12
4. Market Opportunities	
(a) Hemp Insulation	13
(b) Hemp Board	33
5. Product Manufacturing	
(a) Hemp Insulation	45
(b) Hemp Board	45
6. Agricultural Production	
(a) Hemp Insulation	59
(b) Hemp Board	59
7. Conclusions & Recommended Actions (Evaluation of Risks, Potential Benefits and Strategic Options for Alberta-Based Producers)	68

1. Purpose and Scope of Report, Methodology and Acknowledgements

Two particular ecologically-friendly building products have been identified as being of potential interest to Alberta producers, by the *Green-Building Ag-Based Material Project Team* of Alberta Agriculture and Rural Development (ARD) and Alberta Finance and Enterprise (AFE). They are:

1. Hemp Insulation Products, and
2. Hemp Boards

The Project Team has commissioned this report to determine if these products *prima facie* are potentially financially viable in an Alberta setting. The report assesses the market opportunities, manufacturing requirements and agricultural production conditions required for commercial success. This is a preliminary assessment, presented as a **business case** for each of the two products. Further research and analytical work is anticipated by the Project Team. It is intended that the business cases will be presented to private sector firms in Alberta – as product options for them to review. Importantly, ARD and AFE wish to develop from this report a province-wide commercial strategy that ultimately could assist Alberta-based growers attract potential processing partners, distribution channel partners and investors.

As part of the background to this project and report, the Project Team knows that the green building market in North America is expanding rapidly. The Project Team was aware that the market for hemp insulation and hemp boards already had been developed – to at least an initial stage – in Europe. Producers and distributors in Europe had been identified. Part of the terms of reference of the assignment was to contact them and evaluate the potential for European and Alberta-based firms to work collaboratively in developing the North American market. This approach was favored by the Project Team because it recognized that **Alberta offers an opportunity for scale of production** that may not be available in all European supply regions. In addition, technical papers had noted that industrial hemp crop yields and quality in Alberta are among some of the best in the world. Thus, with a focus on the very large potential of the United States market, the Project Team was anxious determine if industrial hemp as a large scale commercial crop potentially can provide a launch platform for a variety of processing and further manufacturing activities centered on production in Alberta.

In this context, the Project Team has requested that a follow-up implementation strategy should be included as a key part of this report.

Methodology

Most of the research was carried out through a combination of desk analysis and field work, which included meetings industry experts, manufacturers and distributors in Germany, Holland and the United Kingdom during November and December 2008. This included visits by the consultant, along with John Leurdyke of AFE, who is a member of the Project Team. The consultant also had several meetings with insulation manufacturers, distributors and homebuilders at the International Builders Show (IBS 2009) in the United States in January 2009.

Acknowledgements

Particular thanks are due to Gary Newman, Managing Director of Plant Fibre Technology Ltd, of Bangor, Wales, UK for his helpful advice throughout the project and permission to use photographs; and to Dr. Christian Brueck, Member of the Management Board of Kosche Group in Germany for his kind guidance relating to hemp board economics. In addition, the report authors wish to thank Lori-Jo Graham, Project Manager for this project and Lead, Green Building with ARD. Thanks are also due to other members of the Project Team including Trevor Kloeck, Richard Gibson, John Leurdyke and Patti Breland.

Disclaimer

The consultant has made every effort to confirm the data and findings presented in this report. Nevertheless, all readers of this report who subsequently use the information are responsible for verifying it. The consultant does not accept responsibility for the accuracy of any data which has been provided, nor for any commercial decisions or investments made relating to the report. The views expressed in the report are those of the consultant alone, and do not necessarily reflect the views of the Project Team, ARD, AFE or ARC or any of the individuals or organizations mentioned in the report.

2. Emerging Markets for Earth-Friendly Building Products

Hemp Insulation and Hemp Boards: 2009 Global Recession Context

Since the terms of reference for this project were developed, much has happened within the world economy. Globally, the world has slipped into recessionary macro-economic conditions (source: World Bank, February 2009). This was not anticipated as recently as a year ago. In the United States, a 'long slide' in new residential construction planning is still continuing (Exhibit 1). For 2008, U.S. housing starts totaled 904,000 units – which was 56% below their most recently peak level in 2005, and a record low. A substantial overhang of new unsold inventory of single family homes exists in the U.S. and re-sale activity and home prices have declined sharply. These housing market and macro-economic woes are repeated in most regions of the developed world. Unemployment is rising. Internationally, a systemic and pervasive credit crisis is proving difficult to resolve. Although the pre-conditions for an eventual recovery of business and consumer confidence exists, a quick recovery is not expected.

Under these types of conditions, what are the prospects for these new products to become widely accepted by building code specifiers, architects, homebuilders, trades-people and homebuyers in North America?

Suppliers of existing products are unlikely to stand-by passively and not fight to retain – and grow – their respective market shares. Producers of 'pink' fibreglass insulation, for example, have a well-established presence in the North American market. Leading manufacturers, such as Johns Mansville, have well-established distribution links and enjoy long term loyalties earned over many years among architects, homebuilders and building inspectors.

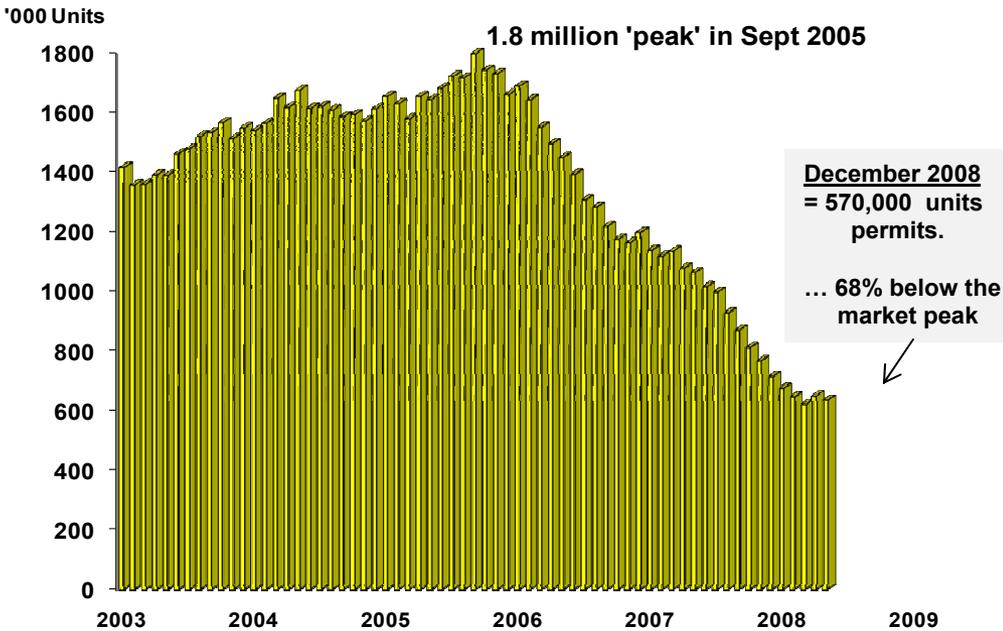
In the composite board market (where hemp boards have to compete) existing manufacturers of medium density fibreboards (MDF) and particleboards (PB) have responded to the market's need for lighter weight boards by offering similar products.

On the other hand, many established producers are struggling to respond to rising consumer demands for 'green' building products. In residential markets, homebuilders have been very responsive to these emerging needs but also are aware that, historically at least, consumer have not always been willing "to pay extra" for green products. There are indications that this may be changing, but at what pace will the transition occur – and among which buying groups?

In industrial markets, LEED and similar certification programs are facilitating the adoption of innovative new green products. So too are alternative energy proposals and tax credits introduced by the U.S. administration. Even so, new 'green' products have to pass quality and consistency standards, and gain buyers' acceptance. In this section, existing and future commodity and niche markets for hemp insulation and hemp board are explored and evaluated.

Exhibit 1

US Single Family Permits: 'The Long Slide'



Permits data are on a seasonally adjusted annual basis (SAAR)

Data: www.census.gov



Emerging Markets for Earth-Friendly Building Products

North American Demand for Low GHG Emitting, and Green-Building Products

Governments internationally, regulators and consumers are concerned increasingly about 'planet issues' and 'pocketbook issues' (Exhibit 2). This is a relatively recent dual phenomenon. In terms of household thermal insulation, for example, most North American homeowners have been quite ambivalent until recently about the need for higher residential standards. Historically, they have had few sustained concerns about rising space heating prices – or global energy prices (Exhibit 3). In addition, until recently most North Americans paid scant heed to concerns about airborne particulates that might emerge from products such as fibreglass insulation and duct covers.

Today, concerns about global warming and the need to reduce greenhouse gas (GHG) emissions have raised the prospect in North America of a carbon pricing mechanism – most likely involving a 'cap and trade' system of carbons credits. In recent years too, consumers and businesses have been hit by rapidly rising purchased fuel costs. There now appears to a shift from purely voluntary action on many of these issues to a regulated approach. Moreover, consumer values are evolving rapidly in the direction of net zero impacts (e.g. net zero energy housing) and an emerging willingness among some to pay a price premium for energy efficient and low or zero GHG products. Importantly, manufacturers and the construction industry are shifting the raw materials they use, and the products they design, build and/or manufacture, to comply with these trends.

Exhibit 2

Today, "Planet" and "Pocketbook" Issues are Both Seeking 'Green-Product' Solutions

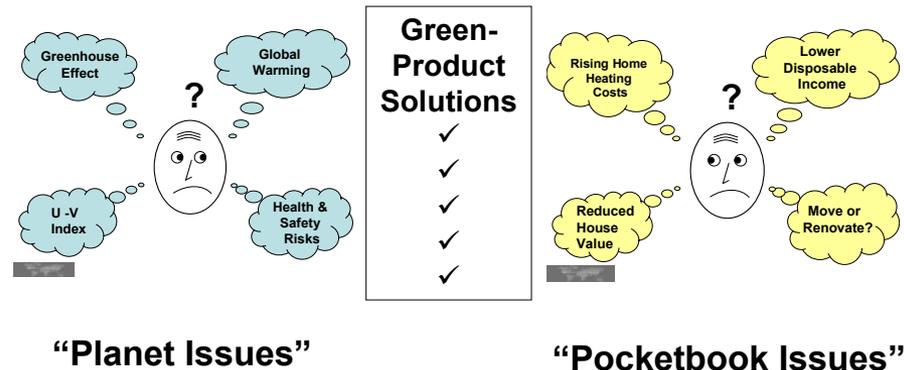
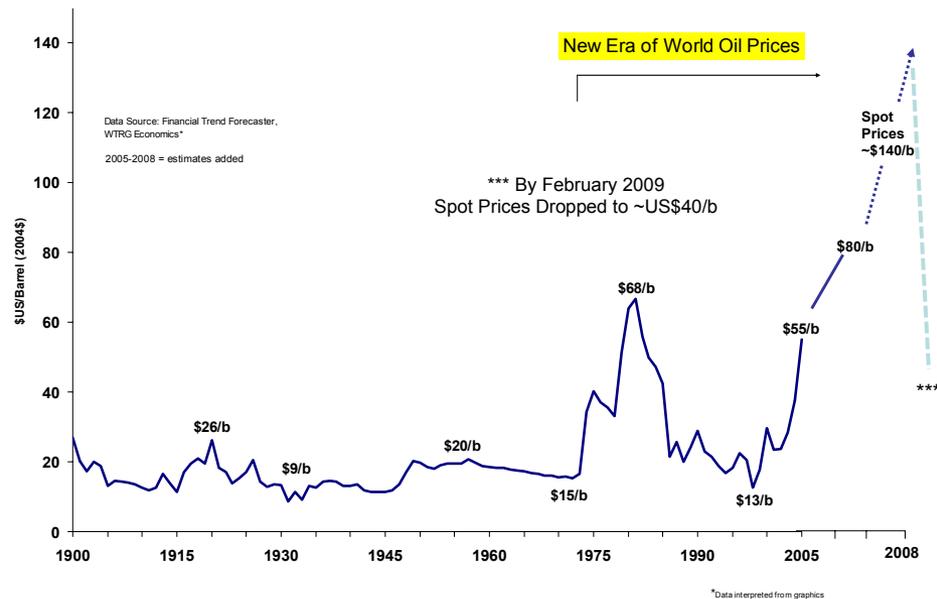


Exhibit 3

Crude Oil Prices (Inflation Adjusted)



Emerging Markets for Earth-Friendly Building Products

Home Buyers' and Homebuilders' Attitudes to Home Energy Costs

One of the assumptions, widely made in green building literature, is that North American homeowners are concerned about their home energy costs. It is also assumed that these concerns stem from both “pocket book and planet” issues. In other words, the assumption is that higher home energy costs will motivate behavioral changes among consumers – that they will either conserve energy by reducing consumption and/or invest in more energy efficient systems in their homes.

As far as most homeowners are concerned, empirical evidence disputes this assumption –at least as far as past behavioral responses are concerned.

JCHS Study of Energy-Related Remodeling

This June 2006 study, by the highly credible Joint Centre for Housing Studies (JCHS) at Harvard University (<http://www.jchs.harvard.edu> : study NO6-2) examined the extent to which American consumers have responded so far to higher home energy costs by investing in energy efficient retrofit investments. The study concluded that these investments have been made in only a small percentage of cases. In other words, consumers have not in the past responded to higher energy costs by making even very modest investments in low cost solutions, such as higher levels of wall and roof insulation. This suggests that the willingness of most homeowners undertaking renovations does not favor spending on insulation upgrades. Clearly, there is a strong and growing group of home-owners and homebuyers who demand high energy-efficiency standards (and several homebuilders and communities exist in Alberta who are global leading edge players in this regard). But it's not yet a mass-movement in North America –despite recent spikes in energy prices.

The JCHS study observed that, with sustained high levels of home energy costs, this behavior might change. Evaluation of patterns in several European cities, for instance, suggest that this might be the case. The study noted, however, that first phase responses of the small group of consumers who act pro-actively comprise mainly (a) minor lifestyle change (e.g. turning down the thermostat) and/or (b) adding weather-stripping and upgrading insulation levels –notably in previously un-insulated attics.

Homeowners' Attitudes to Green Building Products

Who Decides?

A study prepared by Professional Remodeler magazine in 2002 (www.housingzone.com) titled '*Who Decides...?*' indicates that various decision makers are involved in determining purchase decisions in remodeling. This and other studies indicate that higher insulation levels are not the highest priority for remodeling expenditures –but that most North American homeowners consider remodeling to be a good opportunity for upgrading insulation to building code standards (but not beyond).

Developing a Green Building Culture

As note earlier, there are two main schools of thought, in terms of the construction industry's willingness to shift to 'green building'.

A: The '**mandate-it**' movement led by interest groups who seek voluntary, but potentially mandatory, standards to be imposed by the consumer and specifying authorities – including architects, engineers, government departments, cities, building code specifiers. Support is given by a wide range of groups including those noted, and by change activists. This movement is strong in Europe.

B: The '**voluntary guidelines**' movement led by the NAHB (which has developed its own voluntary guidelines). This is supported by homebuilders and others.

'Mandate-It' Regulations

With the new (Obama) administration in Washington, as of early 2009, it appears that zero carbon targets and energy efficiency in buildings might become the standard for the USA –as they are in many countries within the European Union. If this occurs, as expected, it will help the growth in demand for products such as hemp insulation.

Emerging Markets for Earth-Friendly Building Products

North American Market Size – Overview

Definitions of 'green building materials' vary widely. The definition used in this report focuses on all construction materials. Freedonia estimates that the total size of the market in 2005/06 was US\$ 15.7 Billion (Exhibit 4a: see next page for more recent estimates). This is based on the definitions summarized below and discussed throughout the report. Private non-residential construction accounts for 40% of the total market, and the public sector a further 37%. Canada has a disproportionately large share (compared with its population) of the private non-residential market –indicating the strength of Canada’s resource construction projects (e.g. oil and gas, mining) and construction of industrial, commercial and office buildings. Residential housing (including home improvement) comprises 23% of the total market –and 94% of this is in the United States. Our definition of green building excludes a wide variety of products such as the following:

Exclusions: Energy Star (and Equivalent) Purchases

- Kitchen Appliances
- Hot Water Heaters
- Efficient Thermostats and Electrical Controls; All Electrical Items
- Land Set-Asides for Environmental Impacts
- Furniture (e.g. Urea free)
- Waste Disposal

Inclusions

Built-Green spending includes the incremental value of product upgrades to achieve:

Energy Efficiency, via

- Improved Levels of Insulation
- Energy Efficient Roofing Details (e.g. soffit)
- More Efficient Windows/Ext Doors
- More Efficient Space Heating & Solar Panels
- More Efficient Wall Framing (e.g. 2x6 Walls)
- More Efficient Basements & Basement Flooring
- More Efficient Mechanical (Excluding Electrical)
- The use of More Efficient Building Materials (e.g. EWPs)

Air Quality, Soundproofing & Enhanced 'Living Space', via

- Non Urea-Formaldehyde Fixtures & Fittings (e.g. Cabinets)
- Discretionary Alterations to Design & Layout
- The Use of More Efficient Building Materials (e.g. EWPs)

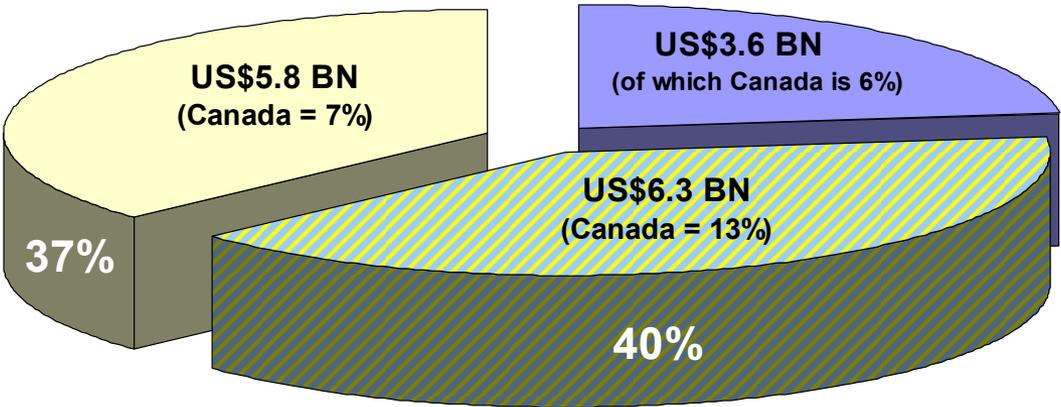
Reduced Environmental Impacts, via

- Utilities (e.g. water metering; waste management)
- Control of Water Run-Off (e.g. rainwater conservation).

Exhibit 4a

North America: Green Building Product Demand Estimated Market Size 2005-06

Note Exclusions: See Text



US \$15.7 Billion

■ Residential ■ Private Non-Residential ■ Public



Data Sources: McGraw-Hill Construction, US Census Bureau and Woodbridge Associates Inc. Estimates



Emerging Markets for Earth-Friendly Building Products

North American Market Size – Overview (continued)

As already noted, the green building product market in North America was estimated at US\$17.7 BN in 2005/06. It experienced such rapid growth that, by 2007, projections by Freedonia indicated that the market already was valued at around US\$36-49 BN (Exhibit 4b) and anticipated growth to US\$40-50 BN by 2010. Notwithstanding the huge reduction in residential spending in the United States after 2007, public and non-residential markets continued strongly. By 2009 (the most recent estimate available at the time of this report) Freedonia was projecting further growth to US\$96-140BN by 2013.

Why are green built expenditures on private non-residential and public buildings so buoyant? Quite apart from economic stimulus packages, notably in the U.S., several factors appear to be driving high levels of spending on green built structures and building materials. These are summarized in Exhibit 4c. It suggests that, among the vital demand drivers, architects' and others' willingness to specify green building materials is a key factor. This is not mirrored in the private-sector dominated homebuilding industry. Also, willingness and ability to pay are key factors. On the supply-side, the industry structure in private non-residential and public construction is far more conducive to defining and enforcing industry standards. Importantly, approved certifying agencies, such as LEED, are very strong in the non-residential construction sector.

Exhibit 4b

Exhibit 4c

North America's Green Building Products Market Rapid Growth!		
2005/06	=	US\$ 15.7 BN
2007	=	US\$ 40-50 BN by 2010
2007	=	US\$ 36-49 BN Actual
2009	=	US\$ 96-140 BN by 2013

Source: McGraw Hill

Most of Growth (But Not All) in Non-Residential Buildings

Why are Green Built Expenditures on Private Non-Residential and Public Buildings so Buoyant?
<p><u>Demand Drivers</u></p> <p>#1 Construction Spending Levels</p> <p>#2 Willingness to Specify (A) Voluntary: Architect, Designer, Developer, Finance Co., Engineer, Builder (B) Mandatory: Building Codes and Regulations</p> <p>#3 Willingness & Ability to Pay Building Owner, Finance Co., Building Tenant, Homebuyer</p> <p><u>Supply Drivers</u></p> <p>#4 Industry Structure</p> <ul style="list-style-type: none"> • Is it Conducive to Green Building as Standard Practice? • Does it Affect Competitive Edge? <p>#5 Existence of Approved Certifying Agencies (A) Non-Residential (e.g. LEED) (B) Residential (e.g. NAHB Green Building Code and LEED for Housing)</p>



3. Product Development & Commercialization Goals in Alberta: Producers' Perspective

Market Driven vs. Grower Driven Perspective

This report approaches the industrial hemp opportunity in Alberta from a market perspective, rather than from a grower's viewpoint. No apologies are offered for this approach. In fact, it is strongly in the interests of the potential grower and processor to be aware of the market and competitive factors that ultimately will dictate the financial success, or failure, of industrial hemp cultivation.

Several observations support a market-driven approach.

#1 Industrial Hemp Too Often Is Considered as an Alternative Crop

Farmers who are interested in industrial hemp growing frequently are seeking an alternative to a single crop that is the mainstream of their business. From the product buyers' viewpoint this is not desirable. The hemp processor and the buyer of hemp products typically require a long term commitment by the grower to the crop. Without the assurance of reliable supplies of hemp fibre, capital providers (banks and equity shareholders) are very reluctant (and may be completely unwilling) to provide capital and operating funds essential for processing and manufacturing plants.

Processors also know that they can achieve essential, steady improvements in crop quality only by working with growers over a period of time. This is a vital aspect of their ability to achieve a competitive position in the marketplace. Too many farmers have the attitude of "here's the crop, pay me my money". They do not perceive themselves as being part of a longer term industrial enterprise. As a result, they do not dedicate the effort required to achieve the best crop yields and, post-harvesting, often they do not handle the crop (e.g. retting) in an optimal manner.

Thus, it is important – in our view – for potential growers of industrial hemp in Alberta to fully understand the complete supply chain, and to know where the potential value exists – so that as much as possible of the potential value attributable to their efforts can come back to the farm.

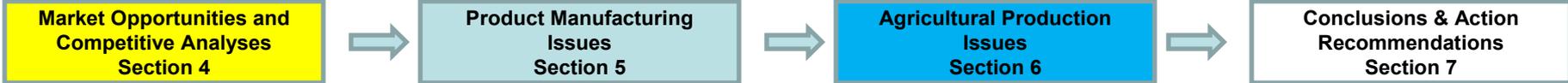
"Farmers in regions of the country that are highly dependent upon a single crop, such as tobacco or wheat, have shown an interest in [the potential for industrial hemp] as a high value alternative crop –although studies conducted so far paint a mixed profitability picture."
'Hemp as an Agricultural Commodity' CRS Report for Congress (March 2007) Jean M. Rawson

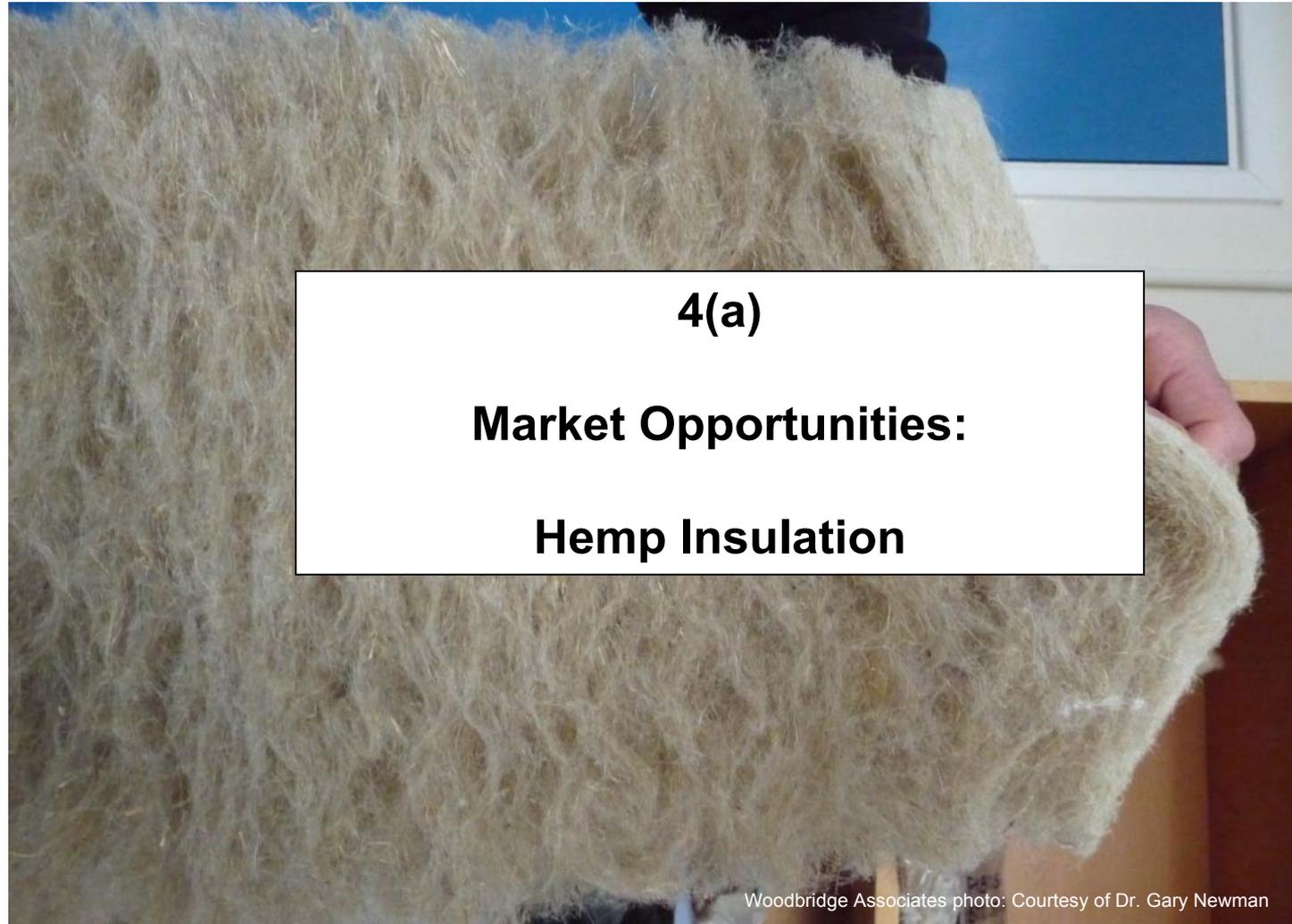
#2 Hemp Products are the 'New Guys on the Block'

Hemp fibre and other industrial hemp products have been part of commerce throughout history. Hemp has been an important source of oilseeds, coarse fabrics and paper. More recently, industrial hemp has been used for industrial oils, cosmetics, pharmaceuticals, fine fabrics and cigarette papers. In these respects, it is not a 'new' fibre, as such. In relation to potentially emerging products – including hemp insulation and hemp boards – however, hemp has to find a competitive position in well established markets. In the case of both hemp products, not only are other products well-established in the marketplace, they are supported (in many cases) by a well-developed (and tightly guarded) supply-chain infrastructure and delivery channels. Gaining a foothold in these markets can be tough!

From the point of view that the two industrial hemp products evaluated in this report are 'the new guys on the block', it is essential to drive the opportunity analysis and evaluations from a market acceptance perspective. In addition, our approach assesses the likely revenues per unit that these products can expect – from the perspective of the various price-points they will have to fit into, if they are to achieve sustainable market share growth. Thus, the layout of this report is as follows:

Exhibit 5





Woodbridge Associates photo: Courtesy of Dr. Gary Newman

Market Opportunities: Hemp Insulation

Thermal Insulation Market Size

The size of the thermal insulation market in North America, and the size of the market for composite boards (within which hemp boards would compete), are both so large that an exact dollar value estimate becomes virtually meaningless for the purposes of this report. Neither of the two industrial hemp-based products could be expected to achieve more than a fractional share of the market – especially during their initial years of becoming established. More importantly, it is helpful to potential producers to segregate the market (and market growth potential) within which both products primarily would compete.

In addition, as part of assessing the best ‘go-forward’ strategy for these products, it is vital to identify:

- #1. The unique selling points (USPs) of the two industrial hemp products in order to ascertain where most likely they would fit into a niche sub-market role.
- #2. What their competition is likely to be, and at what price points this would occur.
- #3. What the growth in their respective market s is likely to be. This is important because, for a new product, *participating in the growth in demand* typically is comparatively less difficult than trying to displace an existing product and/or supplier in an already well-established market and supply-role.

Exhibit 6

North American Market for Thermal Insulation

Estimates place the total value of the U.S. thermal insulation market at around US\$8.5 Billion in 2008 (source Freedonia). Separate estimates indicate that the market size in the U.S. alone was \$7.2 Billion in 2005 (source SBI).

Historical growth rates in demand within the U.S. are estimated at 7% between 2004 and 2005 (the peak of the U.S. housing market). Projections indicate a short term slowing growth rate at 5% CAGR (SBI), creating a U.S. market valued at U.S.\$9.5 Billion by 2010 (SBI). Projections by Reportlinker indicate a 6% rate of demand growth, indicating a US\$11 Billion market by 2012. These sources note that tax credits and incentives have helped spur this growth.

Data from Owens Corning (which has #1 position in the industry in North America) indicate that five major product groups share this market. Fibreglass insulation held an estimated 48% of the total market (data probably are 2007 shares) compared with 38% for rigid foam, in 2nd position. Spray foams accounted for around 9% of the market while cellulose (including any industrial hemp insulation sold in North America) accounted for 4% of the total. Mineral wool held an estimated 1% market share (Exhibit 6).

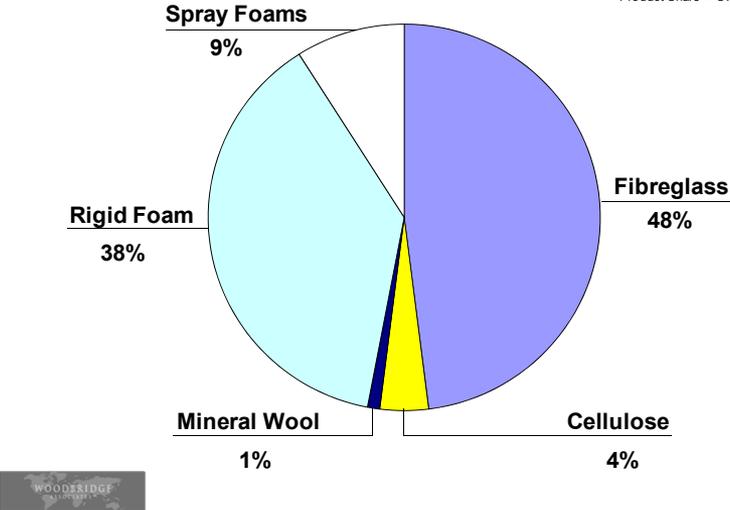
Hemp Insulation: Target Market Size

In ball-park terms the cellulose based insulation market was valued at an estimated U.S.\$340 million in 2007, and could rise to at least U.S.\$440 million by 2012 assuming that it does not increase its market share. With the unique selling point (USP) of being a natural fibre product, cellulose could be expected to increase its overall share – perhaps indicating a U.S.\$500 million market for cellulose insulation in the near future and more rapid growth beyond.

North American Insulation Market: Product Share*

Total Market Value = US\$8.5 Billion (2008)**

Sources: ** Market Value = Freedonia
* Product Share = Owens Corning (2008)



Market Opportunities: Hemp Insulation

The Cellulose Thermal Insulation Market Niche

With about 4% of the North American market, cellulose thermal insulation serves a niche market. Cellulose insulation is used mostly residential situations, but also has developed several non-residential applications. We assume that 75% of the total market is residential, with 25% being industrial, agricultural and other non-residential uses. Overall use data for the U.S. and Canada are similar, but fewer second homes in Canada (e.g. cabins and vacation homes, sometimes located in remote areas) are believed to use cellulose insulation than typical second homes in the United States. This may be linked to transportation issues in Canada, and more difficult installation issues in second homes.

Studies show that that the cost (materials plus installation labor) of thermal insulation for an average single family newly constructed home in the United States in 2005 was around U.S.\$3,000. Assuming that the roof insulation portion, on average, was 40% of the total, this indicates a rule-of-thumb expenditure per home of about U.S.\$1,200 per new home constructed using dry-blown cellulose insulation. In addition, some existing homes are insulated (or re-insulated) using cellulose thermal insulation, and part of this is the do-it-yourself sub-sector. We assume that this mostly is dry blown attic or loft insulation (i.e. not walls), with an assumed cost of perhaps \$1,000 per existing housing unit. Moreover, we estimate that the existing home (home improvement) market accounts for about two-thirds of the residential cases where cellulose insulation is installed. Wet sprayed insulation methods are used to apply cellulose insulation to walls and some other areas. If cellulose insulation is applied to the whole house (attics/lofts and walls) the estimated number of homes treated, shown below, would be lower – but the project value per home would be larger.

On this basis, the cellulose insulation market in North America most likely comprises the following segments. Data are approximated and rounded.

- 70,000 new residential homes built in North America (4.5% of starts) used cellulose insulation in 2007 –a U.S.\$85 million market.
- 170,000 existing residential homes in North America used cellulose insulation in 2007 –a U.S.\$170 million market.
- The non-residential, industrial and agricultural market in North America in 2007 was valued around U.S.\$85 million.

These estimates indicate the comparative strength of the existing home market (sometimes called the ‘re-insulation market’) for cellulose insulation (Exhibit 7). As noted, the do-it-yourself segment probably is a significant portion of the total, and may be related to the rapidly growing ‘green market’ for building products.

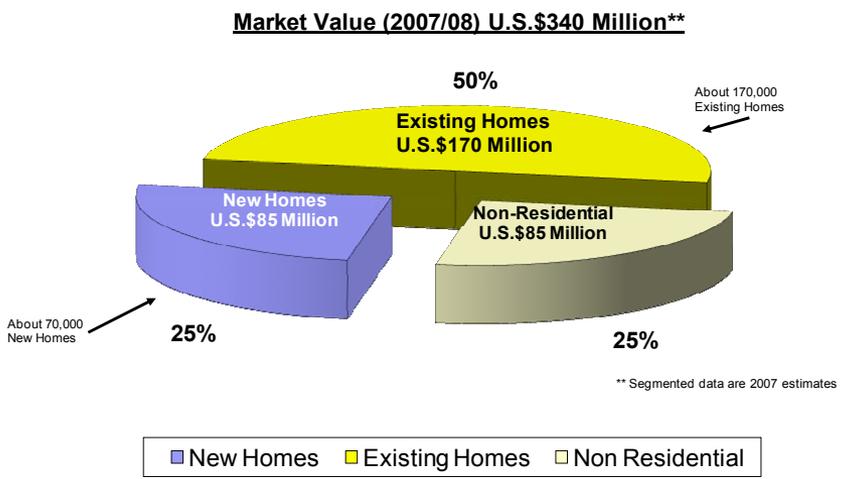
Cellulose Thermal Insulation Products

These include products made from re-cycled newsprint, cardboard, , as well as cotton and other cellulose products, such as hemp fibres.

In most cases, they require different applications. Wet blown newsprint-based cellulose insulation requires equipment (a blower, and protective clothing) while cotton and hemp insulation is available in batts (similar in application to fibreglass insulation but, in the case of these natural fibres, with few or no issues related to health concerns).

Exhibit 7

Estimates of Cellulose Thermal Insulation Market in North America - By Major Segment



Segment Estimates: Woodbridge Associates Inc.

Market Opportunities: Hemp Insulation

Newsprint-Based Cellulose Products

Cellulose insulation, made with recycled newspaper or cardboard, along with a fire retardant, began in the 1950s and came into general use in the United States during the 1970s (source: Wikipedia). The industry grew rapidly for a time, but was adversely affected by 'barriers to entry' into U.S. insulation markets after U.S. regulatory authorities (the Federal Consumer Products Safety Commission) passed a law in 1978 (16 CFR Part 1209), which set rigorous fire safety standards for cellulose insulation. Wikipedia notes that, in 1985, the CPSC asked Congress to repeal the flammability standard after further studies. But, by 1991, only 61 cellulose producers (vs. 350 in 1978) still remained in the U.S. In the meantime, the U.S. fiberglass industry had benefited from most of the regulations passed by the federal government. Heavy lobbying by the more centralized fiberglass and mineral insulation manufacturers had helped pass the tough fire standards for cellulose insulation (Wikipedia).

Wikipedia notes that cellulose insulation is composed of 75-85% recycled paper fibre, usually post-consumer waste newsprint. The other 15% is a fire retardant such as boric acid (which it notes is about as dangerous as table salt) or ammonium sulphate. Wikipedia notes that four major types of loose-fill cellulose products have been developed under a variety of brand names. These are generally characterized as dry cellulose, spray applied cellulose, stabilized cellulose and low dust cellulose. These types are used in different parts of a building and for different reasons.

The following descriptions are provided on the Wikipedia website for cellulose insulation (http://en.wikipedia.org/wiki/Cellulose_insulation).

Dry Cellulose (Loose Fill)

Dry cellulose is used in retrofitting old homes by blowing the cellulose into holes drilled into the tops of the walls. It can also be blown into a new wall construction by using temporary retainers or netting that is clamped in place then removed once the cellulose has reached the appropriate density. This form of application does settle as much as 20% but the stated R-value of the cellulose is accurate after settling occurs. In addition, a dense-pack option can be used to reduce settling and further minimize air gaps. Dense-pack places pressure on the cavity, and should be done by an experienced installer. (source: Wikipedia).

Spray Applied Cellulose (Wet-Spray)

Spray applied cellulose is used for applying cellulose to new wall construction. The only difference is the addition of water to the cellulose while spraying. In some cases the insulation might also mix in a very small percentage of adhesive or activate a dry adhesive present in the cellulose. Wet-spray allows application without the need for a temporary retainer. In addition, wet-spray allows for an even better seal of the insulated cavity against air infiltration and eliminates settling problems. Wet-spray installation requires that the wall be allowed to dry for a minimum of 24 hours (or until maximum of 25% moisture is reached) before being covered. (source: Wikipedia)

Stabilized Cellulose

Stabilized cellulose is used most often in attic/roof insulation. It is applied with a very small amount of water to activate an adhesive of some kind. This reduces settling and decreases the amount of cellulose needed. This can prove advantageous at reducing the overall weight of the product on the ceiling drywall helping prevent possible sag. This application is ideal for sloped roofs and has been approved for 5:12 (41.66%) slopes. (source: Wikipedia)

Low-Dust Cellulose

The last major type of cellulose insulation on the market is low dust variety. Nuisance levels of dust are created during application of most types of dry insulation causing the need for simple dust masks to be worn during installation. This kind of cellulose has a small percentage of oil or similar dust dampener added. (source: Wikipedia).

Strategic Issues for Hemp Insulation

Regulatory barriers, along with aggressive lobbying by vested interests, frequently prevent new products from entering or gaining acceptance into a market. This may be relevant when developing an appropriate strategy for hemp insulation (see later sections).

Market Opportunities: Hemp Insulation

Projections of Long Term Market Revenues for Alberta-Based Growers and Processors of Industrial Hemp

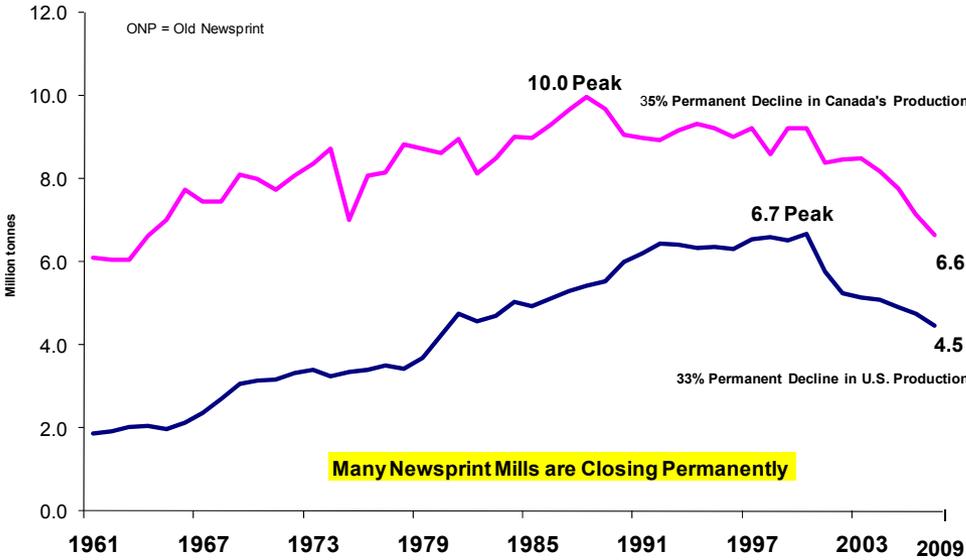
Decline in North American Newsprint Consumption and Production

An important assumption underlying the projections in the previous pages is that newsprint (and other post-consumer paper) supplies will continue to diminish and that prices for this furnish (an essential raw material for newsprint-based cellulose insulation) will rise – making this product substantially less competitive. In addition, offshore demand for recycled papers (notably from China and other Asian countries) is very high – if current world recessionary conditions are set aside. Moreover, offshore demand for ONP (old newsprint) has in recent years forced prices up sharply. Similarly, the global demand for cotton waste also is high under normalized macro economic conditions –making growth in market share difficult for this product.

Exhibit 8

Newsprint: Sharp Decline in North American Production

Supplies of ONP for Cellulose Insulation are Declining Sharply
- and Will Become More Expensive



Unfortunately for newsprint-based cellulose insulation manufacturers –but fortunately for other cellulose insulation producers (including hemp) – the closure of numerous newsprint mills over the past decade will result in ever-tightening supplies of old newsprint (ONP). Exhibit 8 shows that there has been a 33%-35% decline in North American output since production peaked. Moreover, these are long term trends related to loss of newspaper advertising revenues, lower readership because of the iNet, and losses of market share to electronic media.

The production trend is downward, and the loss of newsprint production capacity is permanent. North America is a large exporter of ONP – notably to Asia. Rapid growth in this trade has pushed up ONP and all re-cycled paper and paperboard prices. When the global economy recovers, newsprint-based cellulose insulation producers will have to compete with strong offshore demand for this raw material. Moreover, because it is made overseas into paper, Asian and other countries can afford to pay a reasonable price to secure their supplies from North America.

This means that newsprint-based cellulose insulation producers increasingly will be raw-material constrained as the global economic occurs. These constraints will limit the market growth for newsprint-based cellulose insulation manufacturers – despite expected rapidly rising demand for thermal insulation throughout North America. But, potentially, this is ‘good news’ for producers of hemp insulation.

Newsprint-based cellulose insulation producers increasingly will be raw-material constrained as the global economic occurs. Potentially this is ‘good news’ for producers of hemp insulation

Business Update: Hemcore and Hemp Technology went into administration in early 2009, and subsequently were acquired by Lime Technology. Under the new owners, the Hemcore brand name will be retained but as part of a long term growth strategy the business will be renamed Hemp Technology Limited, a wholly owned subsidiary of Lime Technology.

Market Opportunities: Hemp Insulation

Cotton Insulation

Similarly to wood cellulose paper-based insulation, cotton insulation is made from 80% to 85% of post-industrial fibres. It is available in loose fill, or in batts. Manufacturers note that cotton insulation does not contain any harmful chemicals, and it is marketed as a very safe product. It is also available with a radiant barrier. It is eligible for LEED approval (see www.bondedlogic.com) .

It is not the purpose of this report to compare and contrast the respective virtues and attributes of various forms of thermal insulation. Plentiful sources of this information already exist in the public domain. Instead, in the context of existing products serving the market, the report seeks to determine the likely future market for hemp insulation in North America.

Hemp Insulation

Hemp insulation is manufactured in Europe, although sometimes intermittently, and is associated with names such as Isonat, Hemcore (now Hemp Technology, see above) and Steico. Unlike all other forms of cellulose insulation, it is not produced in the United States (see details later in report). In Canada, Parkland Industrial Hemp Growers (further details later) was established with a business plan, in part, to produce hemp insulation for the North American market. The pictures in Exhibit 9 and 10 illustrate the European product (Isonat). Manufacturing details are provided in a later section.



Woodbridge Associates photo: Courtesy of Gary Newman



Woodbridge Associates photo: Courtesy of Gary Newman

Market Opportunities: Hemp Insulation

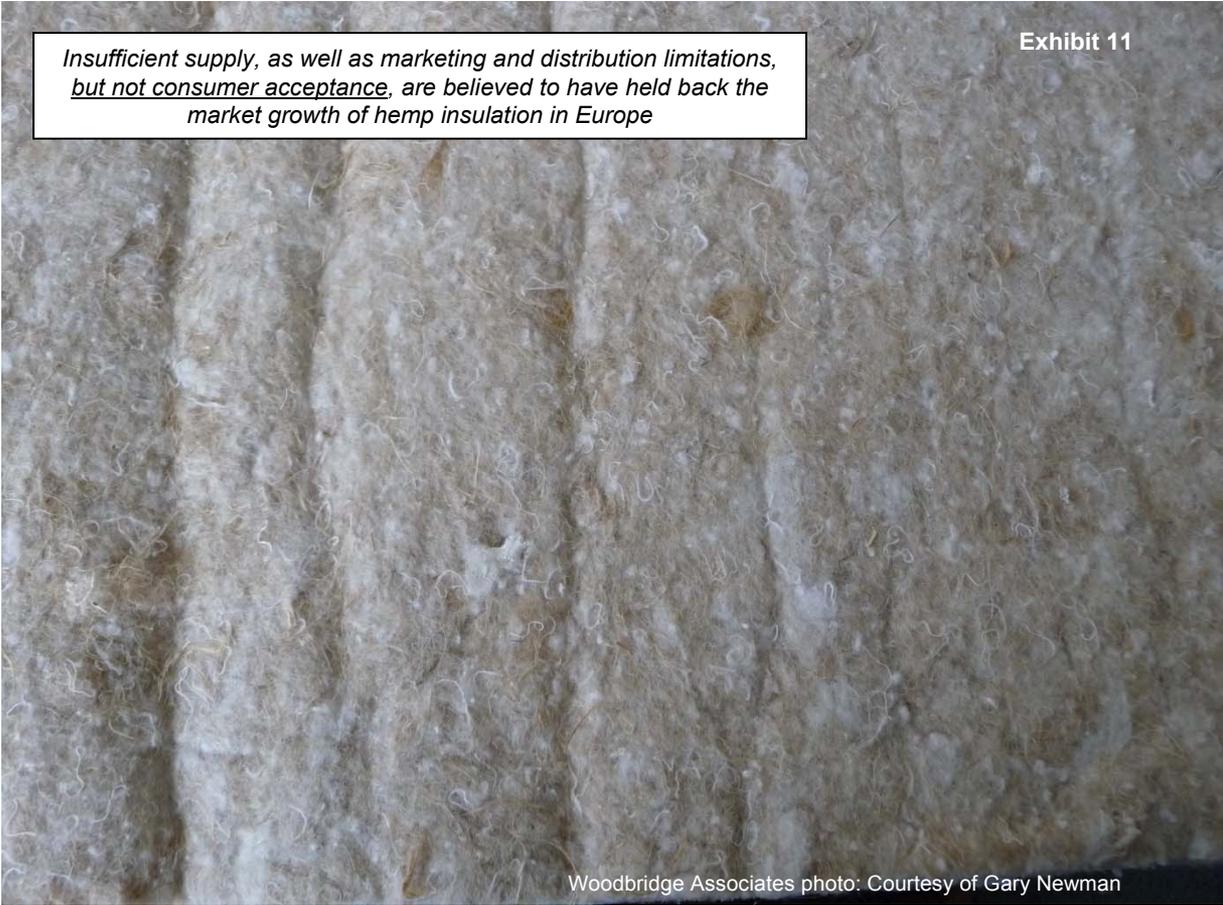
Hemp insulation sometimes is claimed to be the 'ultimate green building product'. As noted in a later section, all parts of the crop can be utilized. Many of the products manufactured from industrial hemp displace products which produce green houses gases (GHGs). Hemp insulation has many distinguishing attributes. Only the fibre itself, plus inorganic non-toxic natural salts and thermoplastic binders, are used in its production. The purposes of the latter are to improve the structure of the batt or blanket, enhance its durability, modify its moisture retention properties and protect the material from insects and rodents. Sometimes, hemp insulation is combined with cotton (Exhibit 11) or other cellulose fibres to meet specific market needs or properties.

European Market Size

The size of the market for hemp insulation within Europe is very small at present. It is widely acknowledged, however, as having significant potential.

One of Europe's largest retail distributors of building materials (B &Q, see Exhibit 12) has been a distributor of hemp insulation and has indicated interest in the product as a 'green building product' alternative to fibreglass and foam insulation.

Although small-scale marketing trials are reported to have been successful, several obstacles have precluded the product from gaining a permanent foothold and building its share of the European market. These obstacles are believed to be supply and distribution, not consumer acceptance!



Insufficient supply, as well as marketing and distribution limitations, but not consumer acceptance, are believed to have held back the market growth of hemp insulation in Europe

Exhibit 11

Woodbridge Associates photo: Courtesy of Gary Newman



Exhibit 12

Woodbridge Associates photo

Market Opportunities: Hemp Insulation

Drivers of Demand: Energy Efficiency Standards in North America

With high and rising fuel costs, it is clear that energy issues are of concern to most homeowners and renters. Over many years, building codes have evolved and have established increasingly high standards for energy efficiency in homes. Insulation materials have improved immensely.

There are efforts underway to introduce uniform building codes in North America, and in construction worldwide (see www.iccsafe.org and www.naffainc.com). Currently, a range of model codes is in existence, and local codes vary to meet specific needs (e.g. high seismic risk or high snow load areas).

With regard to energy consumption in single family homes in Canada, Exhibit 13 shows that R2000 homes are significantly more energy efficient than housing constructed under earlier codes. Further improvements have been achieved with advanced energy efficiency homes – ultimately aimed at **net zero energy homes**.

The Exhibit shows that there have been only minor reductions in energy needs for hot water and electricity in the existing housing stock in Canada. But over the years there have been major improvements in space heating efficiencies – using low cost technologies. From around 128 GJ/y required by typical homes in 1975, energy needs for space heating has declined to approximately 35 GJ/y for R2000 homes.

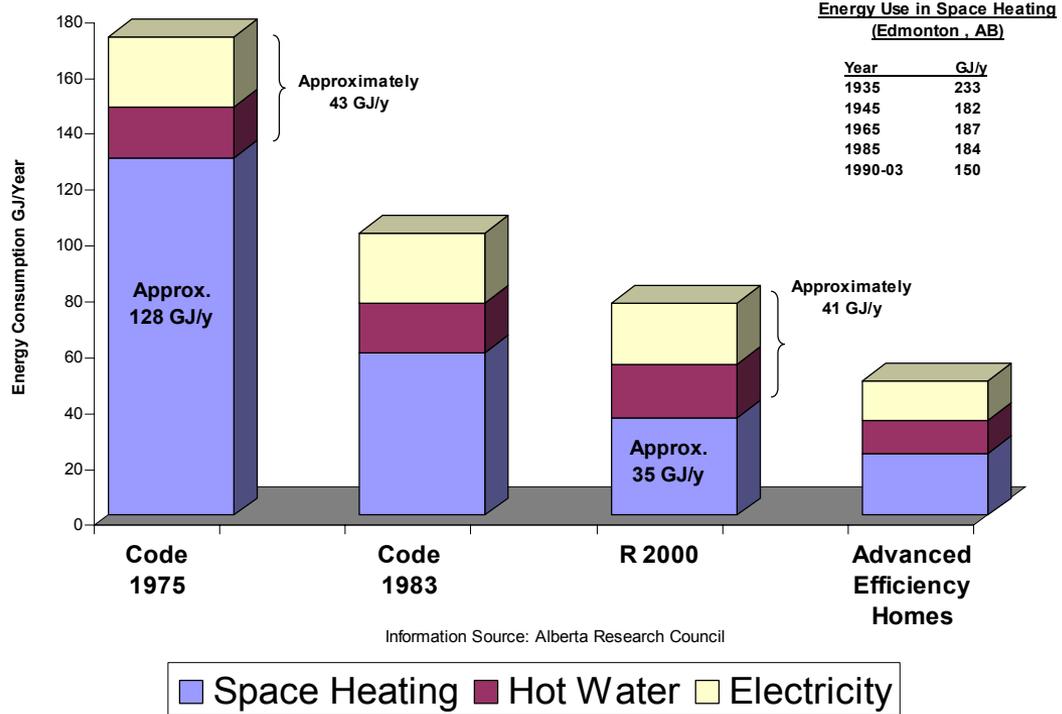
Alberta Research Council (ARC) data show that, for Edmonton AB, typical levels of energy use for space heating purposes declined significantly after WWII, and again after the mid-1980s. Much of this can be attributed to more demanding building code standards – and rising concerns over energy costs.

With continuation of very high energy prices throughout the world, energy efficient new construction (along with concerns over GHGs) have become a matter of public policy. Historically, North America has been slower to adopt these higher standards –but this is now changing rapidly.

Conventional, low cost, technologies (such as fibreglass insulation, weatherproofing and proper caulking) have contributed substantially to energy efficiency in the home. Alternative 'green' building products have to offer significant additional benefits in order to attract consumers' attention. These benefits could include GHG savings; the use of more environmentally friendly materials (such as natural fibres, including hemp); health benefits and ease-of-installation. But some of these are soft factors in the minds of consumers ... and price counts in the buying decision!

Annual Energy Consumption in Canada Single Family Homes

Exhibit 13



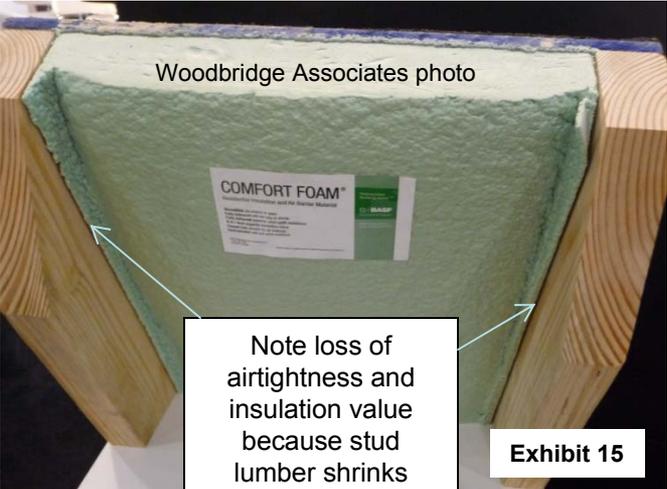
Market Opportunities: Hemp Insulation

Insulation and Air Leakage: Close Cousins

Effective insulation, and the elimination of uncontrolled air leakages, are 'close cousins' in the sense that even the best standards of insulation can be rendered ineffective if unwanted air leakages occur in the building envelope and its interface with the exterior environment. This factor accounts for a significant part of the growth of spray-foam insulation. As noted earlier, hard and soft foams account for 47% of the total market for thermal insulation in North America – and their popularity is growing.

Spray-foams (Exhibit 14) offer the advantage of creating an air-seal, which traditional insulation 'batts' installation finds it difficult to match. One of the many consumer (and builder) complaints about fibre-glass insulation batts is that over time they can sag and become less effective, or sometimes completely ineffective. But air gaps also can occur with spray-on foams – where, for example, lumber shrinks (Exhibit 15).

Thermal bridging is created when materials that are poor insulators come in contact, allowing heat to flow through the path created. Insulation around a bridge is of little help in preventing heat loss or gain due to thermal bridging. The bridging has to be eliminated, rebuilt with a reduced cross-section or with materials that have better insulating properties, or with an additional insulating component (Wikipedia).



Market Opportunities: Hemp Insulation

Whole Building System Solutions: Multiple Insulation Types

Air infiltration (Exhibit 16) has a major impact on the real world R-Value that insulation delivers and, as a result, on the thermal performance of an insulated building. Infiltration of unconditioned ambient air means that heating and cooling systems must work harder to compensate for heat losses (in the winter) and heat gains (in the summer).[source: CIMA].

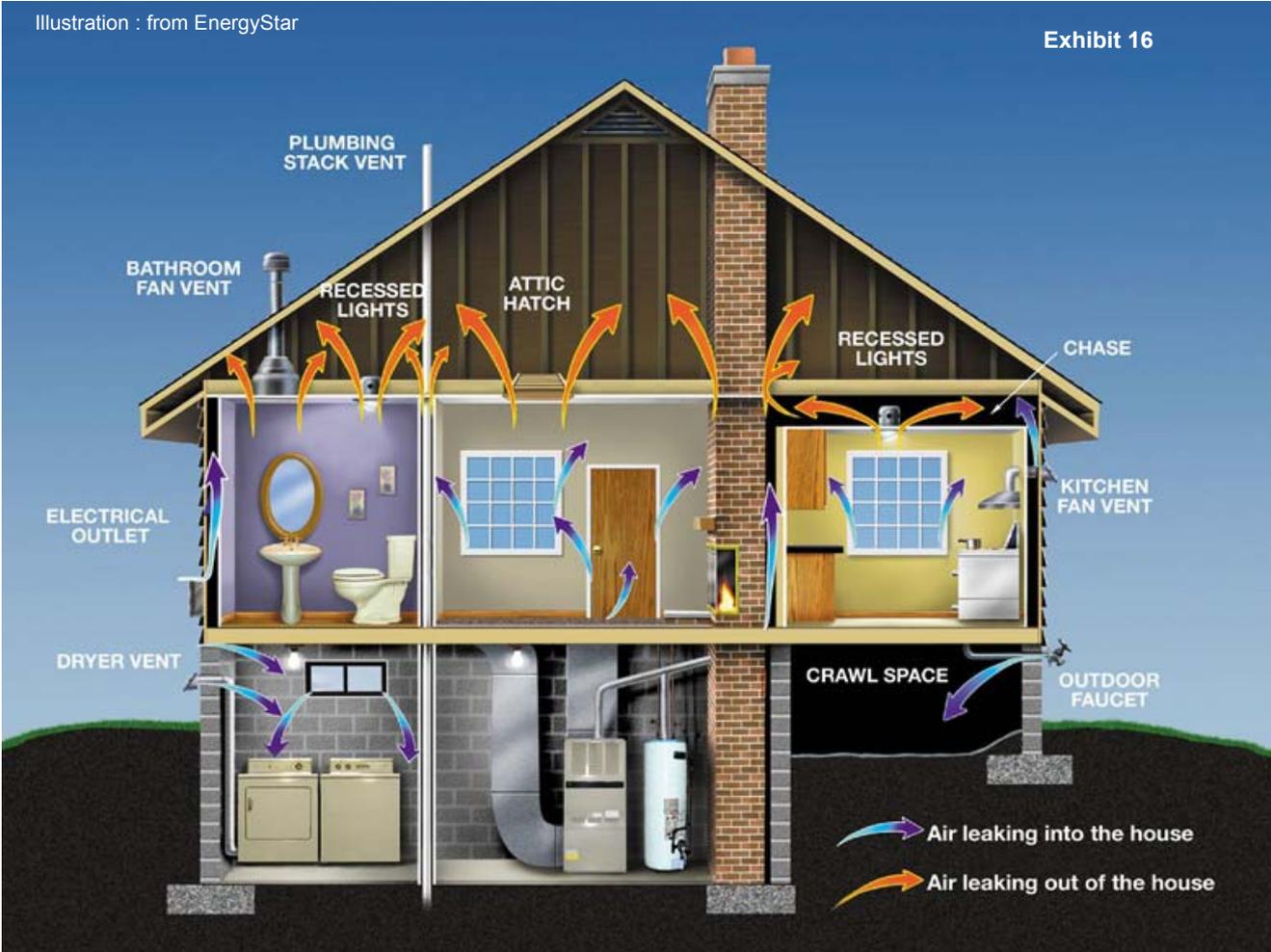
Increasingly, rather than looking at traditional faults such as heat loss/gain; air infiltration and moisture control as separate problems, requiring separate solutions, whole building system approaches tackle them as a single issue – which can be addressed and optimized using multi-product solutions.

Key related issues are sustainable building designs and zero carbon footprint. LEED already has established itself in this regard – with the result that LEED certification for commercial and industrial buildings, and LEED or NAHB certification (‘energy efficiency sticker’) for residential housing, may become part of the building’s re-sale value.

Building codes in the United States and Canadian building code regulators are still a long way from developing such requirements. Since October 2008, however, the British government has required anyone selling or renting a home to obtain an [energy performance certificate](#) that rates the dwelling on an A-to-G scale for efficiency. (source Roxul).

Hemp insulation (with several USPs) could also become part of a wholistic integrated solution.

Cellulose is the only insulation that actually manages moisture. source: CIMA



Source: http://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_sealing

Market Opportunities: Hemp Insulation

How Much is Spent in New Homes on Insulation?

Homebuilders are acutely aware that, traditionally, the North American *new residential housing* market has been very sensitive to insulation costs. Attitudes in Europe and other regions exposed to high purchased energy costs are more concerned about these issues, and insulation standards during construction are generally higher.

Although this situation is evolving rapidly in North America, overall, it appears that most homeowners today still have a fairly low threshold for investing in energy saving technologies – even in the face of relatively high home energy costs. Few consumers appear willing, as yet, to contribute directly towards a reduction in societal costs.

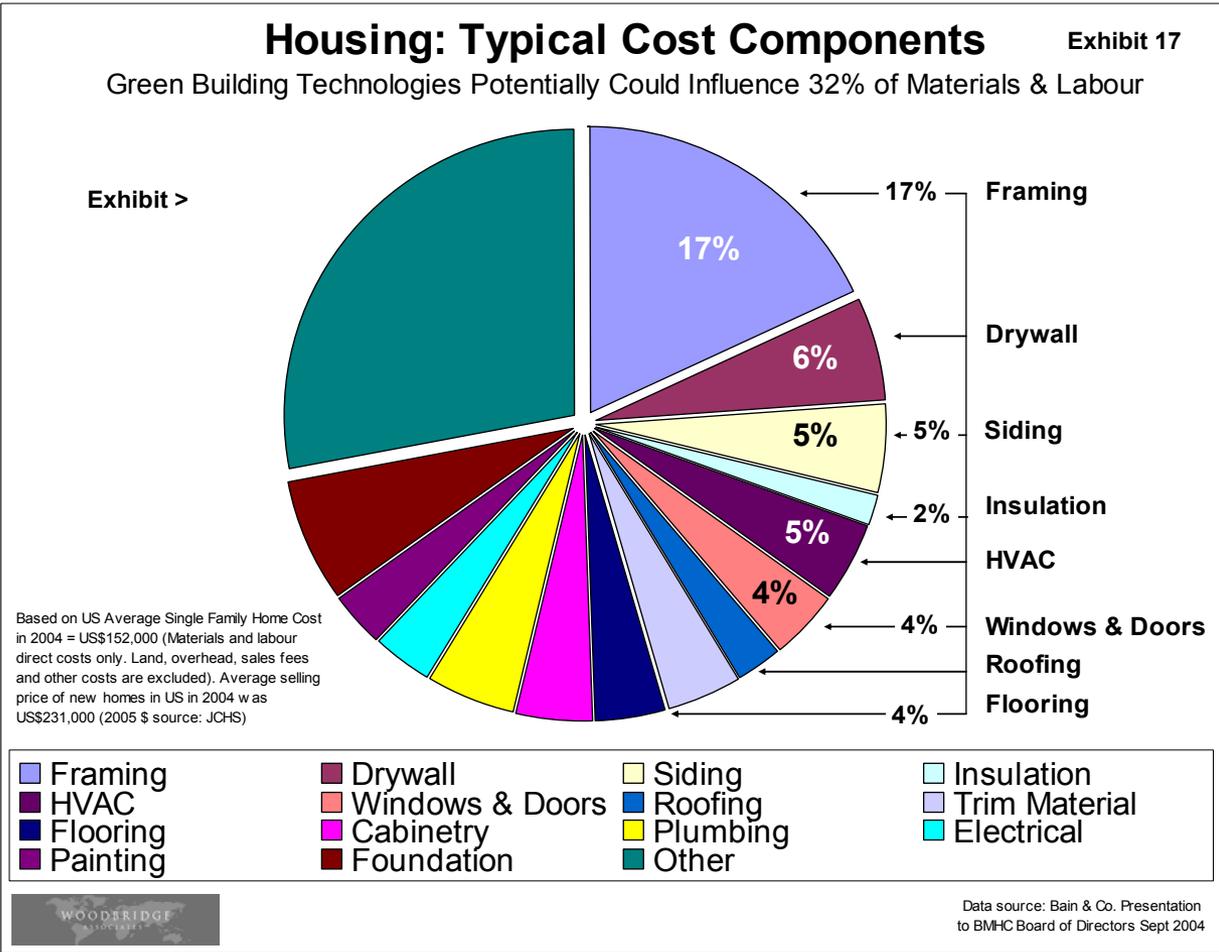
As a result, the insulation industry is very sensitive to the willingness of homeowners to pay for energy efficiency in new residential homes (see text box below). The industry is cautious about advising consumers to ‘over-insulate’. Traditionally, only 2% of the typical cost of a new home is insulation (Exhibit 17), although a whole building approach to insulation, airtightness and moisture control, also would also take into account windows, doors and building structure.

This, we believe, reinforces the business case need for prospective manufacturers of hemp insulation to achieve a very cost competitive product – and win market share by offering a better product than existing insulation types.

To keep initial selling prices competitive, many home builders offer the legal minimum (not optimal) levels of insulation. (NAIMA)

“The amount of insulation you need depends mainly on the climate you live in. Also, your fuel savings from insulation will depend upon the climate, the type and size of your house, the amount of insulation already in your house, and your fuel use patterns and family size. If you buy too much insulation, it will cost you more than what you’ll save on fuel”

(from US Insulation Industry Website)



Market Opportunities: Hemp Insulation

The Home Improvement Market

The home improvement market represents an important **retrofit market** for hemp insulation –notably in attics/lofts and other easy-to -access areas within existing buildings.

North America (like Europe) has a huge housing stock that is below modern code standards in a variety of respects. The total housing stock in the US alone was over 126 million units in 2007.

Exhibit 18

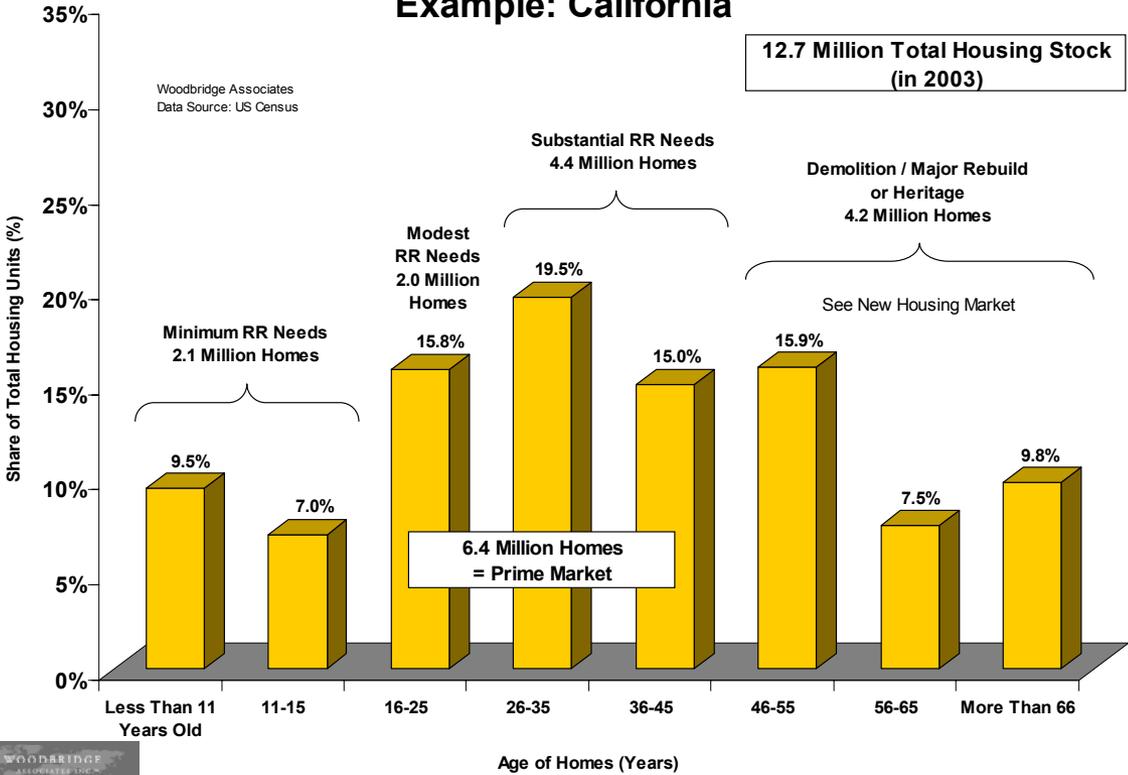
Depending on the state or region, many of these are older homes. A large proportion fall below current code levels for energy efficiency. Proportionally, similar conclusions can be made about the housing stock in Canada. Exhibit 18 presents an example of our projections of residential reconstruction needs in the US (a potential export market for Alberta). In 2003 (most recent Census data), California for example had a total housing stock of 12.7 million units, housing a total population in excess of 35 million persons.

We estimate that around 17% of California’s housing stock is of recent vintage and in most instances meets, or is close to, current code standards. A further 16% has very modest needs in terms of upgradings. Typically, home improvements for these groups of homes involve upgrading of kitchens (new appliances), cabinets, bathrooms, flooring, the installation of new windows, new mouldings and generally investments in higher grade living conditions.

But nearly 35% of California’s homes require substantial improvements –including structural and often substantial investments in energy efficiency. Similar analyses can be carried out for most markets.

For market size assessment purposes, these data provide a broad indication of the maximum scale of the potential retrofit market. For the US overall, *conceptually*, this total market probably is in excess of 70 million existing homes currently. In Canada, it could be around 7.5 million existing homes.

Residential Reconstruction (RR) Needs Example: California



Market Opportunities: Hemp Insulation

Exhibit 19

Non-Residential Markets

As a potential market for green building products, the private non-residential construction sector in North America offers a substantial number of different characteristics – which, we believe, can assist in their early introduction.

The non-residential market (Exhibit 19) is a more diverse sector than the residential market. One vital difference is that most government and commercial structures, such as retail outlets and warehouses, do not compete for the buyers' or leaseholders' attention based on the same criteria used by housing market buyers. Specifically, apart from location, "street appeal" of the structure is a high priority for homebuyers. It is far less important for buyers and owners of non-residential structures.

Another significant difference is that owners and leaseholders of retail, hospitality and commercial buildings that are frequented by consumers (e.g. shoppers) are generally quite sensitive to 'green issues'. In particular, as membership in the LEED program demonstrates, the majority of decision makers involved in building design in this sector generally are acutely sensitive to issues such as energy efficiency.

"Approval" by consumers (e.g. shoppers) of commercial operators whose buildings are built-green is very strong –and is far ahead of the equivalent types of consumer ratings linked to most homebuilders (although there are some notable exceptions of leading edge built-green homebuilders and high acceptance by some groups of homebuyers).

Thirdly, the diversity of shapes, sizes, designs and functional types in non-residential construction provide an opportunity for architects, designers, specifiers and building inspectors to explore the commercial potential of advanced energy efficient structural technologies, and green building products.

Additionally, non-residential structures offer scale. Compared with single family housing units, which average 2,400 square feet in North America, non-residential structures (generally 10,000 to 200,000 square feet per unit) offer a larger footprint for commercial testing of energy efficient technologies.

Non-Residential Markets in Alberta for Green Building Products

Market analyses presented earlier indicated that non-residential construction expenditures in Canada during 2005 were around \$179 Billion. Alberta's share of these expenditures in 2005 was nearly 24% -far greater than its share of population, and nearly 3.5 times its spending on residential housing .

Projections indicate that this rise will continue for the foreseeable future. Although a large part of the overall spending relates to oil-sands and oil-gas-mining projects, we estimate that over \$5.9 billion was spend in 2005 on non-residential sectors that are primary target markets for energy efficient green building products. These include a variety of government, public and private buildings.

Typically, these markets are far more receptive than homebuilding to green-built concepts and products. Just 5% of this local market would represent a \$300 million opportunity for energy efficient green building products – supported by strong institutional 'pro-green' policy makers.

Non Residential Construction Markets

Private Sector

- Retail
- Offices
- Commercial and Institutional Buildings
- Light Industrial Structures, including Storage
- Large Industrial Structures
- Agricultural and Other Structures

Public Sector and Military

- Schools & Education
- Government and Public Buildings
- Airports and Transportation
- Other Structures



Market Opportunities: Future Competition for Hemp Insulation

What's on the Horizon?

Could hemp insulation be eclipsed by emerging new technologies? What are these new technologies?

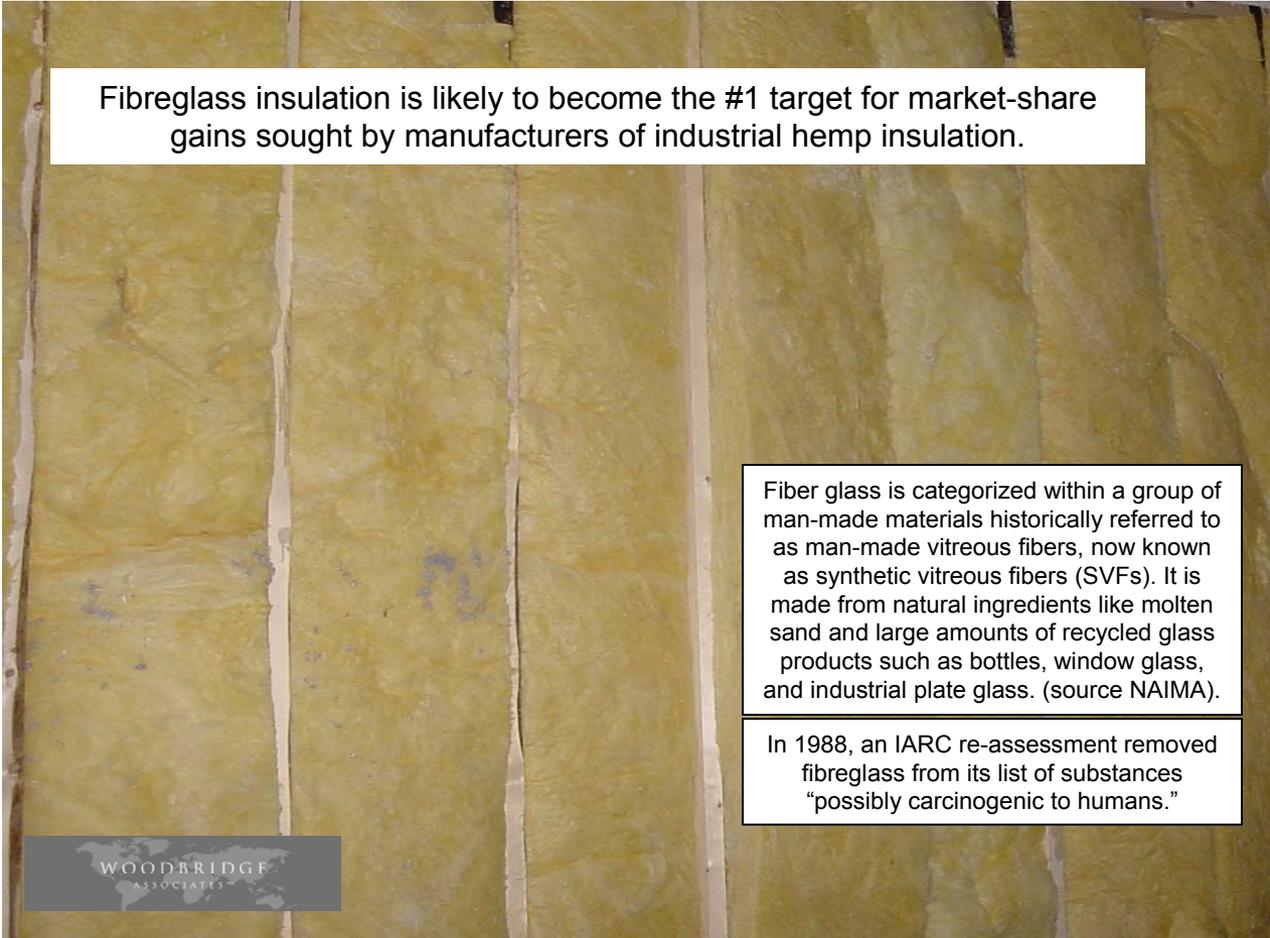
According to E-Source Companies (www.esource.com, for BC Hydro), the best available insulation products have a maximum R-value of about R-11 per inch. Several new insulation technologies exist that have an R-value of 20 or more, but they have not been developed as building insulation products. They include gas-filled panels, vacuum insulation panels and aerogels.

Gas-filled panels, says E-Source, contain multiple pockets of sealed polymer film filled with low-conductivity argon, krypton or xenon gas, which have R-values per inch of 7.2, 12.4 and 20, respectively. Vacuum insulation panels use a vacuum held between two gas-impermeable layers of metal to create R-values of 25 to 40 per inch. Aerogels are low-density solids that resemble wisps of frozen smoke. They are made most commonly from silica and offer R-values of 15 to 35 per inch.

E-Source notes that all three of these are currently used in appliances, such as ovens and refrigerators, but they are too expensive to compete with traditional building insulations. One company, however, developed a granulated transparent aerogel that will be used to create skylights and windows with R-values of eight to 20. The first of these was available in late 2002 and early 2003.

This tends to suggest that, provided hemp insulation can be produced and sold profitably over the longer term at a price allowing it to compete head-on with existing major market share products, notably fibreglass (Exhibit 20). This most likely is the best strategic positioning for hemp insulation to gain market share. This, in turn, reinforces our conclusion about the need for economies of scale.

Exhibit 20a



Fibreglass insulation is likely to become the #1 target for market-share gains sought by manufacturers of industrial hemp insulation.

Fiber glass is categorized within a group of man-made materials historically referred to as man-made vitreous fibers, now known as synthetic vitreous fibers (SVFs). It is made from natural ingredients like molten sand and large amounts of recycled glass products such as bottles, window glass, and industrial plate glass. (source NAIMA).

In 1988, an IARC re-assessment removed fibreglass from its list of substances "possibly carcinogenic to humans."



Market Opportunities: Future Competition for Hemp Insulation

What's on the Horizon? (continued)

A key conclusion of this report is that hemp insulation (in batt or roll form) has the potential to win a significant share of the North American insulation market.

This conclusion is based on the premise that (a) some existing products with high market share – notably GHG-producing fibreglass insulation – is not a green product and (b) hemp insulation is better positioned than many spray-on foams to capture the business of consumers who want a true green product.

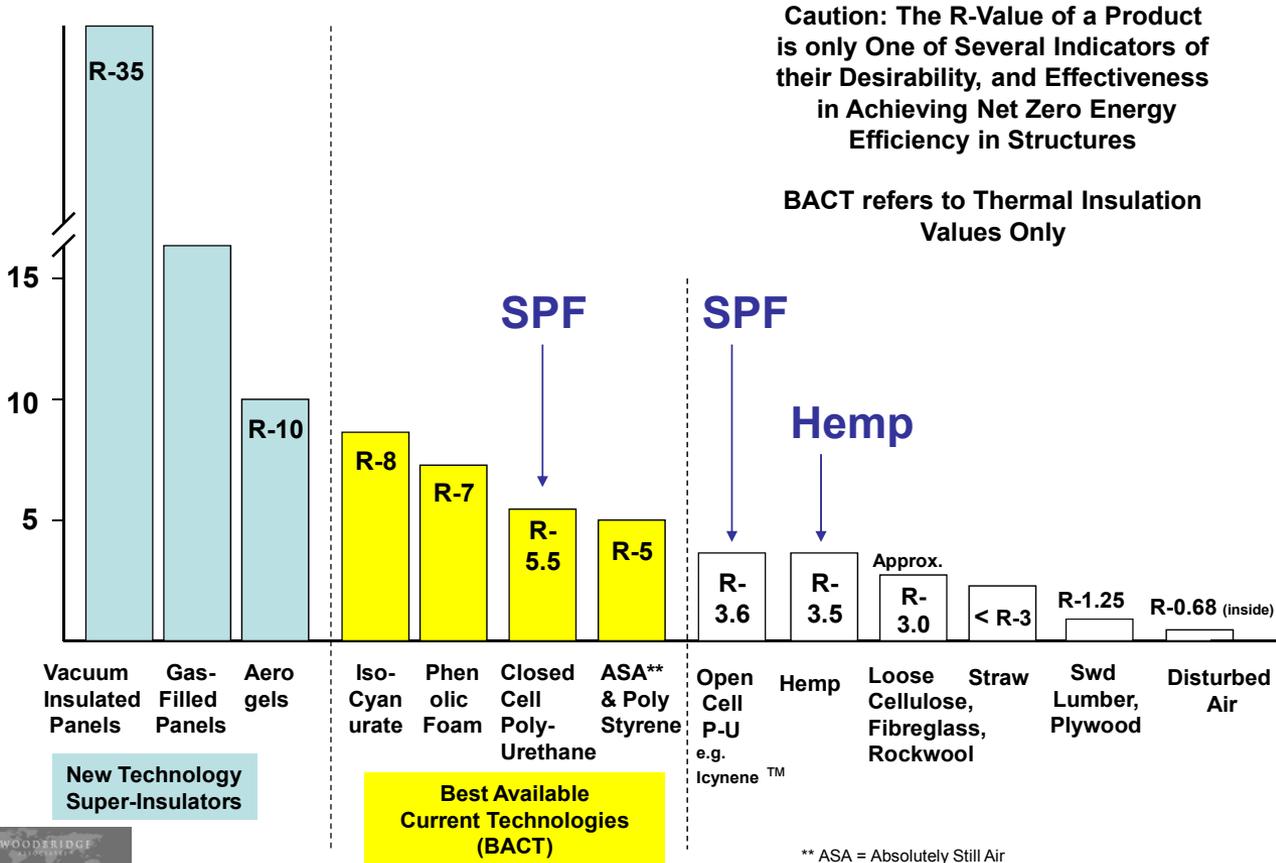
It is further projected that Alberta could develop a significant role as a growing region for industrial hemp – and support processing facilities that could achieve low unit costs of production based on large economies of scale.

But, how does hemp insulation compare on the scale of R-values – particularly against some of the fast emerging products such as spray-on (SPF) insulation?

Exhibit 20b provides the answer. It shows that industrial hemp insulation compares well against SPF in the lower end of R-values – notably compared with open cell SPFs, such as *Icynene*. Although this latter product is made with linseed oil, and thus has a green content, it is not nearly as “green” as hemp for a similar R-value. Hemp cannot compete in R-value with closed cell SPFs and other high R-value insulators but, of the cellulose based products, it has the best R-value. In addition, a high percentage of the market requires a mid-range R-value product.

Exhibit 20b

Thermal Insulation: Comparison of R-Values



Caution: The R-Value of a Product is only One of Several Indicators of their Desirability, and Effectiveness in Achieving Net Zero Energy Efficiency in Structures

BACT refers to Thermal Insulation Values Only

** ASA = Absolutely Still Air

Market Opportunities: Hemp Insulation

Projections of Market Revenues for an Alberta-Based Hemp Insulation Producer

Based on the analyses and market assumptions detailed earlier in this section, we provide below a preliminary estimate of the pro forma revenues for a hypothetical state-of-the-art hemp insulation manufacturer ('NFI Manufacturing') based in Alberta, Canada. These revenues are compared later with preliminary estimates of manufacturing economics (Section 5) and the economics of industrial hemp growing (Section 6).

NFI Manufacturing: Preliminary Market Share Assumptions

The 'Too Small or Too Big' Dilemma

Potential manufacturers of industrial hemp insulation, aimed at North America consumers, risk the dilemma of entering the market either 'too small' in scale or 'too big'.

Dangers of 'Too Small'

'Too small' involves risks such as failing to gain the support of vital channel partners, notably home builders and big box retailers, who require consistent volumes of well-supported product. It also risks launching the hemp insulation product onto the North American market at too high a price premium over dominant existing products (notably fibreglass and foam). This is because small scale production units would not be able to achieve the optimum economies of scale that would yield the low unit costs of production desirable to compete with existing products on a price basis (no price premium for hemp insulation is assumed, as a deliberate marketing strategy). The sensitivity of the North American thermal insulation market to price already has been noted. If start-up producers of a green building product, such as industrial hemp insulation, aim to achieve a significant market share, launching the product with a production unit that is 'too small' will tend to force the product into a niche-product role in the marketplace –with a corresponding image and reputation in the minds of builders, retailers, renovators and the consuming public.

The advantages of going 'too small' are to limit the capital and overall business risks. For a new product, such as industrial hemp insulation that has potential image risks (i.e. image links to marijuana), we do not advocate this approach. The manufacturing firm must be well capitalized with a significant product-launch and follow-up marketing budget. Based on a market strategy of establishing the hypothetical company 'NFI Manufacturing' as an industry leader, and assuming that this venture is well capitalized with top-line management experienced in the insulation business, we strongly advocate the optimum economies of scale defined by major pieces of manufacturing equipment.

Dangers of 'Too Big'

Launching a hemp insulation manufacturing plant that is 'too big' in scale involves a considerable number of financial, market and operating risks. Assuming a well capitalized and well managed operation, however, we believe that an essential sales and pricing strategic principle would be **to establish 'NFI Manufacturing' as the lowest cost, leading-edge quality producer in North America**. It follows, however, that capital providers will require a very detailed and thorough business plan –supported, ideally, by the technical performance results obtainable from a commercial level pilot trial.

Advisability of a Commercial Scale Pilot Plant

This requirement is covered in greater detail in Section 5.

Cubic Metre Calculations

The equivalent cubic metre calculations, on a per structure basis, can be estimated from on-line sources (several insulation manufacturers and distributors provide calculation assistance on their respective websites: see for example <http://www.owenscorning.com/worldwide/canada/calculator.asp?Language=1>). These can be grossed up to provide an estimate of the manufacturing plant's ideal volume from a demand perspective.

Market Opportunities: Hemp Insulation

Projections of Market Revenues for an Alberta-Based Hemp Insulation Producer

Exhibit 21 provides a summary of the most likely levels of sales revenues obtainable from a state-of-the-art facility. These calculations are derived from our assumptions about the market opportunity for industrial hemp insulation. Key assumptions are contained in the table. In particular, the assumed insulation values per household unit equivalent (HUEs) are shown. This is a convenient method of equating all industrial, commercial and other sales to a typical housing unit basis. At peak production, reached we assume in Year 5 of full time operation, a single state-of-the-art industrial hemp insulation plant most likely could serve the equivalent of 50,000 new residential homes per year.

Preliminary Projections of Market Revenues for an Alberta-Based Hemp Insulation Producer ‘Pro Forma’

Exhibit 21

	Start-Up Period	Year 1	Year 2	Year 3	Year 4	Year 5
Annual Gross Revenues from Insulation Sales US\$ Millions	1.0	5.0	11.25	45.0	125.0	150.0
Insulation value per Housing Unit Equivalent (HUE) <i>Materials Only, Excludes Distribution & Installation Costs</i> US\$ per HUE	2,000	2,000	2,250	2,250	2,500	3,000
Housing Unit Equivalents (HUEs) Insulated. Number	500	2,500	5,000	20,000	50,000	50,000

Source: Woodbridge Associates Inc. (Feb 2009)

In fact, this might comprise sales (via distributors) to a variety of markets, such as the home improvement (or ‘re-insulation’) market – where, typically, only loose fill attic or loft insulation may be chosen by the homeowner. As natural fibre insulation gains wider market acceptance, these calculations assume a rising price (and profit margin) outlook. It is assumed that growers will respond to these needs, and that processing facilities (along the lines of the UK Hemcore business model) are in place to serve the insulation plant and other markets with their requirements.

It is assumed that the marketing and sales strategy of ‘NFI Manufacturing’ would target the displacement of ‘non-green’ fibreglass and traditional foam products (i.e. not ‘green insulation’ foam products, such as soy and canola based spray-on). It is assumed that hemp insulation sales would not target other cellulose based markets. In Year 1 of operation, a single plant would require a very modest share of the North American insulation market. This would be the equivalent of just over 1% of the existing (2007/08) cellulose based insulation market in North America and, at peak production in Year 5, less than 2% of the US\$8.5 thermal overall thermal insulation market in North America, based on 2008 values. Significant growth is anticipated in the overall thermal insulation market in North America, with natural fibres taking a disproportionately large share of the growth which occurs. As noted in Section 5, the market growth assumptions for hemp insulation presented in this report presume that costs of production will permit it to be sold on an equivalent price basis with existing ‘non-green’ products, including fibreglass and foams –and that code acceptance will be achieved quickly for hemp insulation.



Market Opportunities: Hemp Insulation

Projections of Long Term Market Revenues for Alberta-Based Growers and Processors of Industrial Hemp

Growers of industrial hemp in Alberta potentially can be expected to be interested in the financial returns they can obtain as suppliers to a single production plant located in Alberta manufacturing hemp insulation. But, they will be even more interested in a longer term commitment to this crop if the sales opportunities extend beyond a single hemp insulation plant. In addition, based on the Hemcore (UK) industrial hemp processing model, markets for other industrial hemp products would have to be involved as an integral part of the supply-chain. This latter requirement is discussed in Section 5.

What is the North American market potential for hemp insulation, and how many hemp insulation plants could be envisaged over a ten year period?

Exhibit 22 attempts to answer this question. Based on the assumption that the overall thermal insulation market in North America grows at a conservative rate of around 6% per year (Freedonia), and assuming that all cellulose insulation selling prices and installation cost remain competitive, we project growth in the market share of cellulose insulation from an estimated 4% in 2008 (Owens Corning) to 8% by 2013 and to 10% by the year 2015.

Moreover because of rising costs of cotton fibres and declining supplies of newsprint, we project that a disproportionately large share of the market growth within all cellulose products will be accounted for by fibre crops, including industrial hemp.

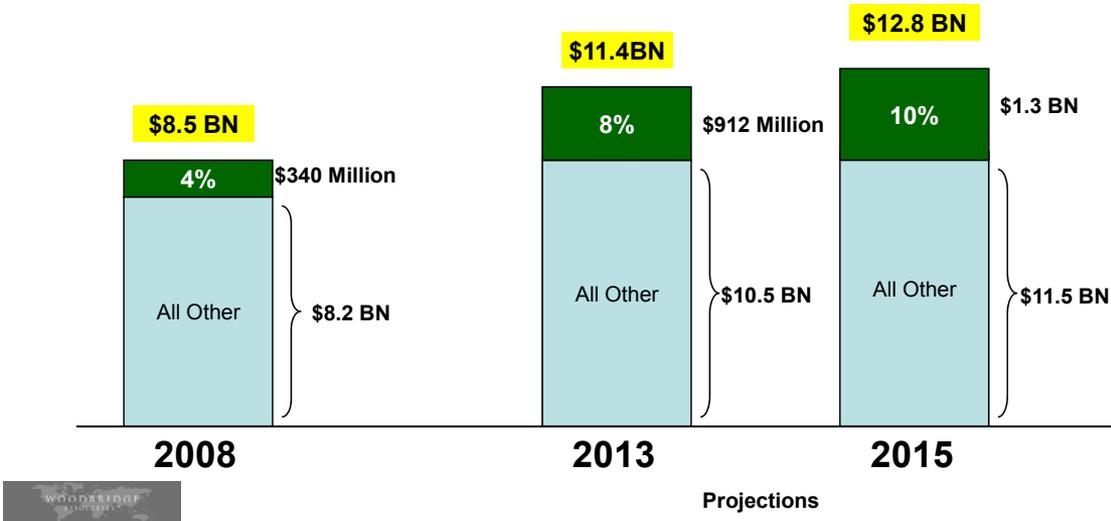
It should be remembered, in this context, that cellulose insulation products gained rapid market acceptance in the 1970s as a result of sky-rocketing global oil prices (OPEC1). They lost market share, not based on performance, but because of regulatory intervention - which, we believe, would be difficult for producers of established insulation products (fibreglass and 'non-green' foams) to replicate with the same degree of success.

Another difference today is that legislators are seeking green solutions. So too are green certification agencies, such as the LEED program (www.cagbc.org/leed/what/index.php) and the NAHB green building program (www.nahbgreen.org). They support not just energy efficiency and air tightness (in which fibreglass and foam perform well) but also take into account GHG considerations in their ratings. This favours cellulose, and fibre crops particularly.

Exhibit 22

Cellulose Thermal Insulation Will Gain Market Share from Fibreglass & 'Non-Green' Foams
- Hemp Insulation has the Potential to Capture a Large Part of This Growth

- x% = Cellulose Insulation (Including Industrial Hemp)
- \$ = North American Thermal Insulation Market Size



Market Opportunities: Hemp Insulation

Projections of Long Term Market Revenues for Alberta-Based Growers and Processors of Industrial Hemp

Number of Insulation Plants

These projections suggest the potential for several separate or inter-linked investments in industrial hemp insulation manufacturing plants in Alberta. For the purposes of illustration we have assumed a straight-line start-up of new capacity (Exhibit 23) although this is unlikely in reality to be the case. To meet the predicted market demand for hemp insulation in North America, a total of four state-of-the-art plants will be required between 2009 and 2013. These will meet market growth needs for 2015 but, by then, additional plant capacity (new plants or expansion of existing plants) will be needed to growth in demand beyond 2015.

Exhibit 23

Industrial Hemp Insulation: Estimate of New Capacity (# of Plants) Required

	2008	2009	2010	2011	2012	2013	2014	2015
State-of-the-Art Hemp Insulation Plants in N.A. (# of Plants)	0	0	1	3	4	4	4	4
New Capacity (# of Plants) <i># of plants may indicate some at start-up, or ramp-up, stage</i>			1	2	1			New capacity needed
Hemp Insulation Gross Sales Revenues (Materials Only) Assumes 100% capacity utilization (U.S.\$ Millions, rounded)			5	22	73	226	445	575
Hemp Insulation Share of Cellulose Insulation Supply %	<1%					25%		45%
Hemp Insulation Share of N.A. Thermal Insulation Market %	Effectively Zero					<2%		<5%

If four (4) state-of-the-art plants were built in Alberta over the period 2009 to 2013, our preliminary projections indicate that market demand would be sufficient to absorb all their production. Some key assumptions are involved, as already noted. If these pre-conditions are not met, the market potential for hemp insulation could be significantly lower than shown in the table. It should be noted also that these are very preliminary estimates, and further work will be required to confirm the validity of supporting assumptions and other factors such as technical feasibility, fibre costs, equipment costs, transportation economics, potential for channel partnerships and so on.

Assuming the plants are built and operated as projected, the volume of industrial hemp insulation entering the North American market from Alberta would be less than 2% of the projected total demand by 2013, and less than 5% by 2015. However, hemp insulation’s share of the cellulose thermal insulation supply could increase eventually to 45% of the total. We believe that this expansion in fibre-crop based insulation is vital given the very sharp decline in newsprint consumption and production in North America, and rising costs of cotton waste.

Preliminary estimates suggests that sufficient demand could exist by 2013 to support the construction and operation of four (4) state-of-the-art industrial hemp insulation plants in Alberta.....starting in 2010-11.



Market Opportunities: Hemp Insulation

Interest in green building extends well beyond energy efficiency

Conclusions

- The thermal insulation in North America was valued at around U.S.\$8.5 Billion in 2008, and is growing at around 5%-6% per year.
- With recent global macro-economic developments (notably what appears to be a new era in global energy prices) and policy changes (favoring energy efficient buildings and low carbon impact construction methods), supported by significant new supporting policies by the U.S. federal government, two developments are likely. They are:
 - A more rapid rate of growth, than in the recent past, in homebuyers' demand for energy efficient and low carbon structures – and a corresponding increase in homebuilders' (along with governments' and permitting communities') desire to ensure they are built.
 - A shift in construction economics for residential and commercial/industrial/non-residential structures favoring (a) whole building solutions to energy efficiency (including net zero energy buildings) and (b) low carbon impact insulation materials and installation methods which, in turn, will help expand the demand for natural fibre and cellulose insulation products.
- Currently, fibreglass insulation dominates the market, with a 48% market share. This dominance has been achieved because the product is affordable, widely available, effectively distributed and commonly used among builders and do-it-yourself homeowners. It has been available for over seventy years, and is very well established. However, fibreglass also has been associated with health and safety concerns. There are claims that it is carcinogenic (a claim hotly disputed by fibreglass industry associations) but there appears to be no evidence that has caused regulatory authorities to place any restrictions of fibreglass use – apart from safe-handling methods.
- Foamed plastic insulation accounts for 47% of the North American thermal insulation market. Along with radiant barriers and reflective insulation, it is one of the most rapidly growing segments. Foamed plastic insulation is more expensive than fibreglass, but is favoured for its ease of application (spray-on, or board form) and is especially popular in non-residential building markets. We believe that this technology and product can be used in conjunction with hemp insulation, in all markets.
- Cellulose insulation (a category which includes industrial hemp insulation) accounts for about 4% of the total market. It is dominated by newsprint-based insulation. Very little hemp insulation is used in North America (due, we believe, to lack of availability) but is available in Europe (albeit with sporadic supply in key markets).
- Our analysis shows that, with the cellulose insulation supply chain, newsprint-based cellulose insulation in North America is likely to have restricted growth – at its historical selling prices – because of a sharp decline in ONP (old newsprint) supply and rising prices for re-cycled paper. This is a vital feedstock for the industry.
- A large number of obstacles will have to be overcome for industrial hemp insulation to become a mainstream thermal insulation product in North America. There are potential obstacles ranging from building code acceptance to competition from existing players in the business (notably fibreglass and foamed plastic insulation manufacturers). Even so, consumer and legislative policy changes are moving in favor of the use of natural fibres in insulation. A 'new' product such as industrial hemp insulation could gain significant market share over the next decade. It would have to overcome the obstacles mentioned, and meet certain commercial thresholds.
- A key threshold is selling price. Thermal insulation markets in North America are very price sensitive. Rapidly growing products, such as spray-on foamed plastics, have a higher materials and application cost – but, among other benefits, can help reduce building assembly time. Achieving a competitive selling price against well established products, notably fibreglass, means that hemp insulation producers will have to achieve substantial economies of scale (i.e. large sized manufacturing plants).
- We estimate the potential demand for four (4) state-of-the-art hemp insulation plants which, by 2015, could attain a 5% share of North America's thermal insulation market.



4(b)
Market Opportunities:
Hemp Boards

Note that, within this section, **low and medium density hemp boards** (which compete with particleboards and MDF) are reviewed separately from **high density hemp boards** (used within the automotive industry).

Market Opportunities: Hemp Boards (Low and Medium Density)

Reconstituted Boards and Composite Boards Market Size, and Production

In terms of markets, **low and medium density hemp boards** compete against a range of reconstituted and composite panelboards produced from a variety of furnishes. Globally, the dominant furnish is wood cellulose (hardwood and softwood species) derived from wood particles produced by the forest industry. Other furnishes used worldwide to produce composite boards include wheat straw, fescues, baggasse, bamboo and other fibres. In addition, plastics and composite plastics also are a competitor. In North America (as in Europe) the reconstituted and composite board industry is very large and well developed. It produces mainly *intermediate products*, such as particleboards and medium density fibreboards (MDF) along with low density (LDF) frequently used as a substrates or “platform” for laminates or other finishes.

Many of these substrates or ‘platform boards’ are used in furniture, millwork and a variety of other applications. Key properties and characteristics include machinability (i.e. the ability to take an edge when processed with a router), stiffness (low bending), uniformity, smooth surface and low cost. The ability to achieve the latter has been a major reason for the rapid growth in particleboard (PB) and MDF consumption –and their production at very large scale, low unit cost modern MDF plants. Reconstituted woods products are made by mixing leftover wood parts with glue or resin (typically urea formaldehyde or phenol formaldehyde) processed at high heat and pressure. Unlike solid wood, with which they compete, they do not have a grain pattern. In this report, we focus on appearance and performance boards used in the furniture, millwork and related uses. Structural composite boards, notably OSB, used in construction are not competitors to industrial hemp boards, and are excluded from this analysis. By excluding structural boards, we can refer to the remaining products reviewed in this section as ‘appearance’ boards.

Hemp Boards Compete Mainly Against Particleboards and MDF

A key advantage of the types of hemp boards produced in Europe is their light weight. Kosche is a significant firm in the European hemp board industry. Many of its hemp boards are used in home improvement applications such as loft (attic) boards, as well as industrial and commercial uses such as in boats and aircraft fitting and fixtures – where weight is a key consideration. Particleboards (chipboards) and MDF are competitors to it.

MDF and Particleboard

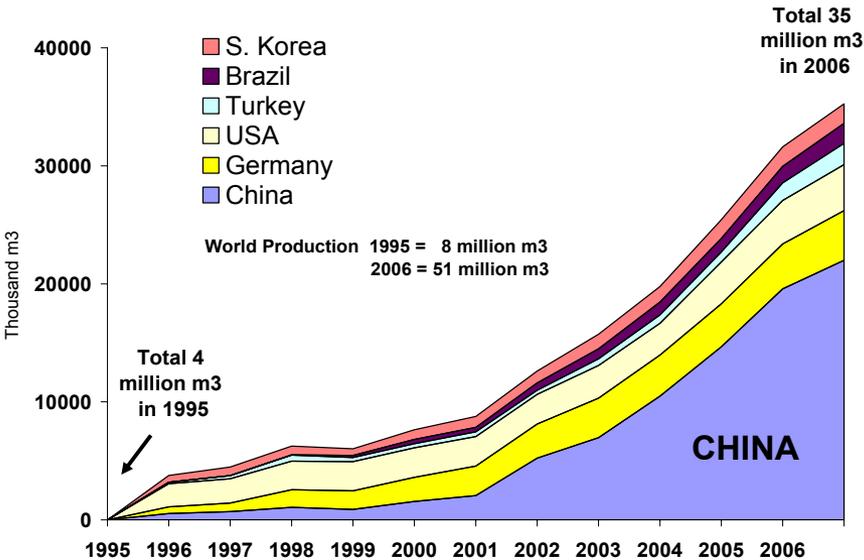
Medium and higher density fiberboards, comprising standard thicknesses and ‘thin board’ are a comparatively new member of the non-structural panelboards family –and have displaced lower density particleboards in several end-uses and, more extensively, have replaced solid sawn hardwoods and decorative softwoods in furniture manufacturing.

World production of MDF has grown rapidly since the early 1990s. Exhibit 24 shows that in 1995, total global production totaled around 4 million m³. This total grew to around 10 million m³ by 2001, but has increased at a double digit rate of growth since then.

Most of the production increase has occurred in China – and has been used as the principal raw material in China’s extensive furniture exports – but significant annual increases have occurred also in Germany (a long time leader in high quality MDF and thin boards for laminate flooring); the US; Turkey, Brazil and South Korea. Canada ranks around #7 among world producers of MDF.

Exhibit 24

MDF Production Global 'Top 6'



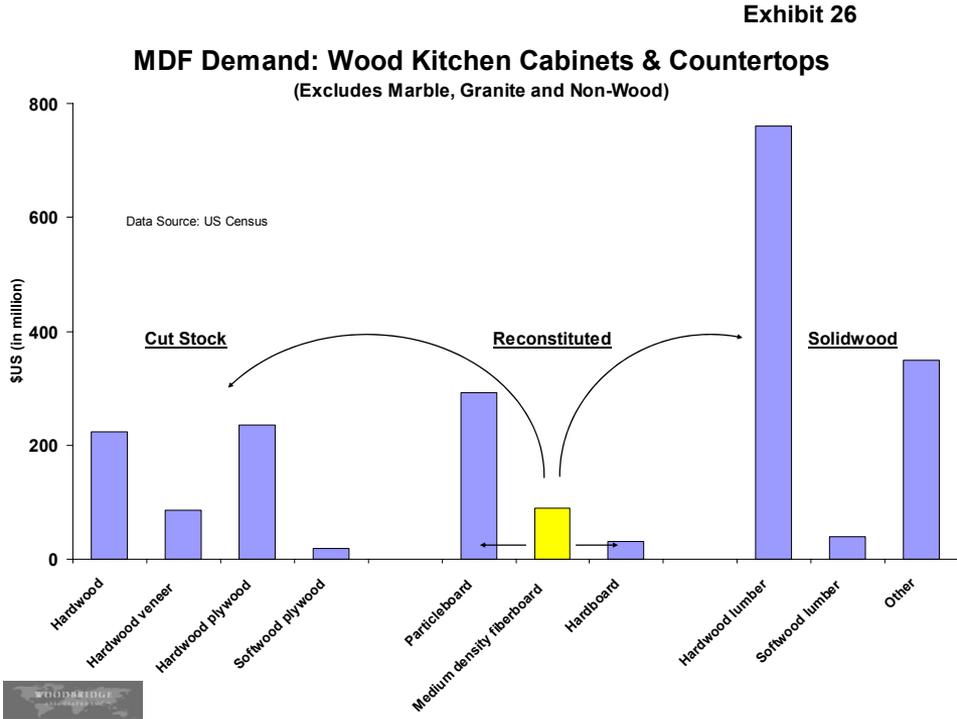
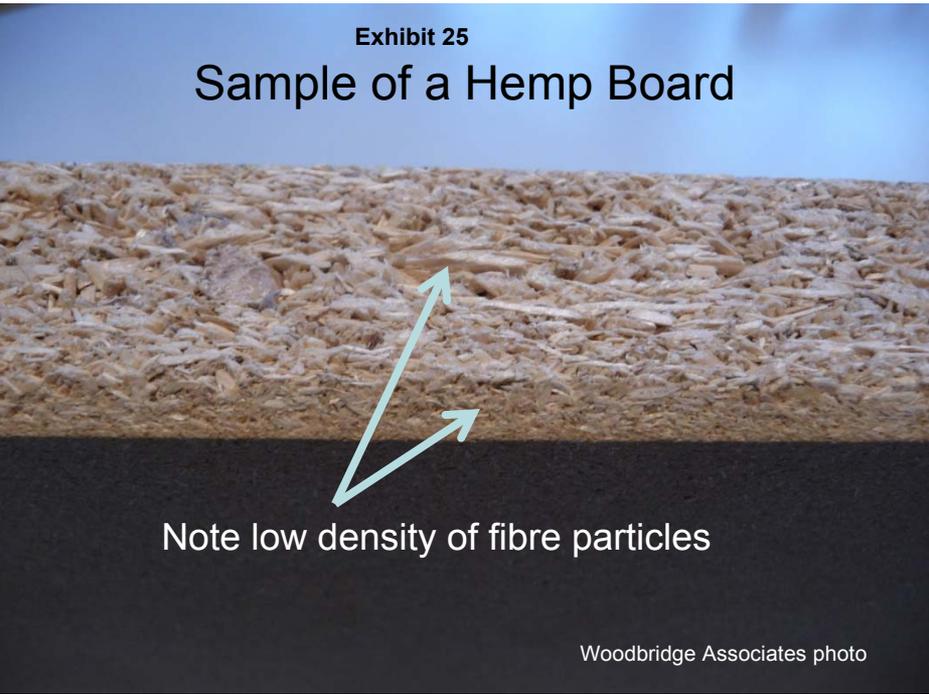
Data source: FAOSTATS

Market Opportunities: Hemp Boards (Low and Medium Density)

Lightweight Board Markets

Where do hemp boards fit in the end-use hierarchy of composite boards? As already noted, in Europe they are produced to meet special needs where weight is important. The size of this market in North America is estimated later in the section. The light weight characteristics of hemp boards are derived from the comparatively low density of the wood or 'chip' particles (bound together with a resin, similar to particleboards/chipboards and MDF).

Exhibit 25 provides an illustration of the typical density of a hemp board produced in Europe. Despite its low density (and low weight per cubic metre) the boards achieve stiffness and rigidity characteristics desired in many other applications –and can compare well in performance against conventional particleboards/chipboards in several uses. In the North American market, however, there has been an ongoing shift away from low density fibreboards and high density hardboards to MDF (Exhibit 26). Moreover, because of the integrated nature of the industry, board processors – such as laminators – are willing to consider almost any product as a platform for their further processing, provided that it meets their quality and price parameters. This has led increasingly to more purpose made composite boards becoming available, and this would tend to trap hemp boards within a very narrow market. As noted later, as well, light weight boards also can be (and frequently are) produced by particleboard manufacturers.



Market Opportunities: Hemp Boards (Low and Medium Density)

The 'Top 6' producers globally account for around two-thirds of total production. MDF is an important raw material in numerous countries and the balance of global output, outside the dozen or so producers is scattered among numerous manufacturers in almost every industrial economy.

North American Production

Canada is not as sizeable producer a producer of MDF and particleboard as the United States, but plays an important role as a supplier of these materials to furniture and casegoods industries (kitchen cabinets, washroom cabinets, shelving, countertops) within Canada and in export markets. Exhibit 27 compares the production volumes of Canada and the US in MDF since the 1990s. In the past, Canada has been a producer of straw-based particleboards (see further discussion later in report) and this is relevant to the prospects for hemp boards manufacturing. However, as the Exhibit shows, production of MDF boards in North America is concentrated in the United States.

The 1990s period was significant for the industry in Canada. During this period, the US ready-to-assemble and wood bedroom furniture industry in the US (notably at furniture manufacturing plants in North Carolina, California and Texas) became uncompetitive.

Plants were comparatively large scale, but productivity was low and vulnerable to lower priced high quality imports from Asia. American and other manufacturers globally shifted their manufacturing base to Korea, Taiwan and ultimately China.

With a low valued dollar, Canadian wood furniture was highly competitive throughout the 1990s – exporting a growing volume of wood furniture to the US. However, with the strengthening Canadian dollar in US funds, and rising volumes of MDF-based and particleboard wood furniture from China being shipped to North America, Canada's competitive position became sharply eroded.

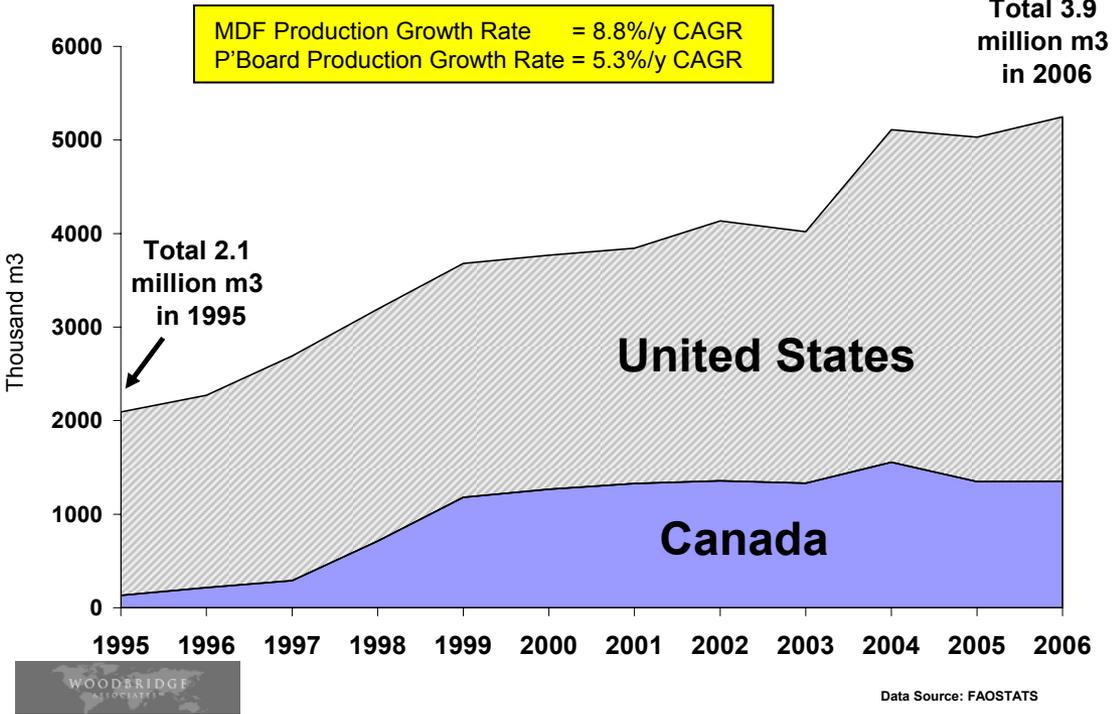
This is reflected in the flat production curve for Canada since around 2000. Production of MDF in the United States, having shown very little growth during the 1990s, began to recover – especially after 2003.

Underlying these trends, several events were occurring. They were:

- A modest recovery in the US wood-based furniture industry from its sharp decline throughout the 1990s;
- In part due to a strong US housing demand cycle (until 2006);
- Also due to capital investment in high productivity casegoods manufacturing.

MDF Production in North America

Exhibit 27



Market Opportunities: Hemp Boards (Low and Medium Density)

North American Production (continued)

In addition, there was strong ongoing demand from the North American kitchen cabinet industry – which was able to remain very competitive – and resist competition from imports – because (unlike the US wood furniture sector) it had invested heavily in productivity, lowering cost and meeting the needs of its customers (ranging from big-box to smaller custom retailers). Another factor was that substantial rationalization and consolidation occurred within the particleboard and MDF manufacturing industry within North America. These trends are reflected in the price trends shown in Exhibit 28.

Some observations are worthwhile:

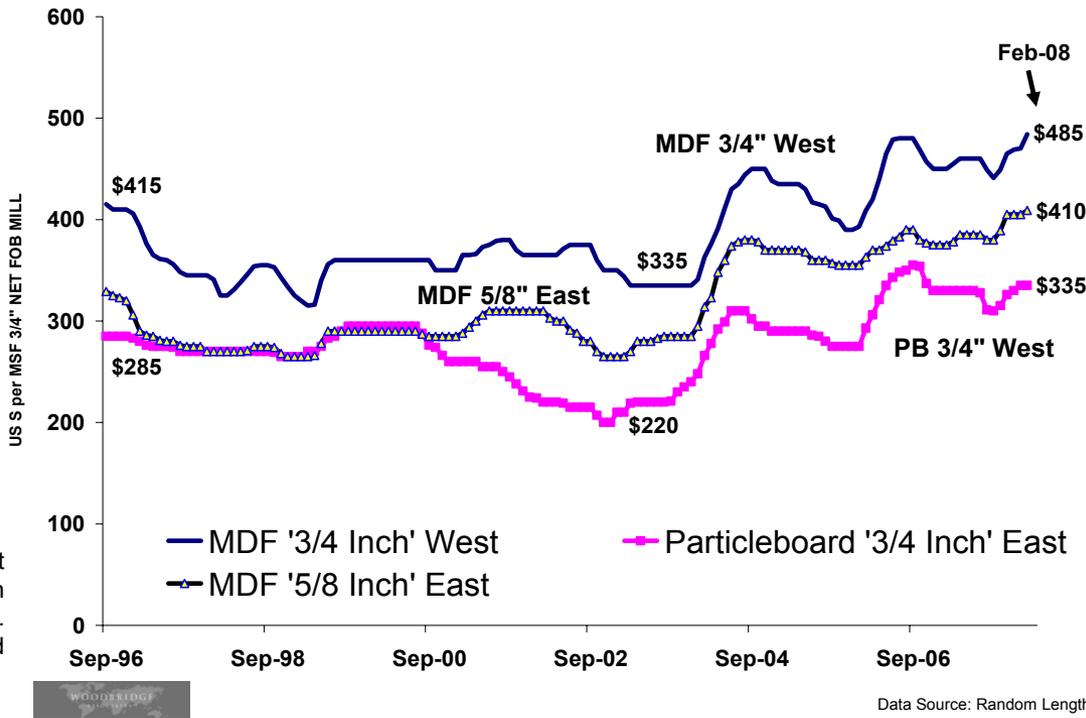
Despite slowing MDF and particleboard market demand relating to declining new home construction and home improvement expenditures during the period 2005 to date, five fundamental supply factors appear to be helping improve the competitiveness of the North American MDF and particleboard industry:

- #1 Reductions in North American manufacturing capacity (and industry rationalization);
- #2 European producers' (notably thin board) loss of currency-induced competitiveness in shipments to the USA;
- #3 Rising costs of fiber for many producers globally (including Canada, but sharper price rises for China and Europe as bio-energy and other users compete for these scarce fiber supplies);
- #4 The ability of the, now smaller but versatile, North American industry to adapt to these changing global circumstances and respond with high quality, price competitive products for the domestic market.

End-uses for many grades and sizes of MDF and particleboard are not commodity markets. There is a highly integrated supply chain within North America (in terms of functional integration, but not usually ownership). Service and the ability of composite panels to respond quickly and effectively to the needs of board laminators, for instance is crucial.

Exhibit 28

Rising Trend in North American MDF and Particleboard Prices



Data Source: Random Lengths

Market Opportunities: Hemp Boards (Low and Medium Density)

North American Production (continued)

Correspondingly, unless importers (notably of MDF) are linked into this domestic supply chain supplying consistent volumes of competitively priced quality products, they tend to be forced into lower valued commodity markets. Domestic producers who are able to serve the specific needs of laminators and end-users are able to focus mainly on higher valued niches, and have to sell only their off-grade volumes into commodity markets.

In our view, these factors will continue to influence the North American industry for the foreseeable future. For Alberta, this implies that the competitiveness of MDF, particleboard manufacturers – while improving on a market price and management performance basis – remains vulnerable to rising fiber costs (as well as resin prices). Competition for white residuals from, for example, price-advantaged^[1] bio-fuel industries (such as wood pellets) is a potentially de-stabilizing factor for the MDF and particleboard industry. It is a situation which is causing concern in many regions, and is generating a review of public policies relating to this issue^[2]. Also important, however, is that many domestic producers have invested heavily into becoming established in value-added markets. They represent an important link with others in the domestic and export supply chain. The value-added multipliers from these manufacturing activities, in Alberta and elsewhere, can be very significant.

Growing tightness in the supply of wood fibre within North America raises the prospect that alternative fibres, such as fescues, wheat straw and industrial hemp, might become viable as these trends evolve. However, as noted later, the commercial success of these alternative fibres to date in the manufacturing of composite boards has not been encouraging. Moreover, in terms of quality, alternative-fibre composite boards frequently encounter problems such as high silicates – which dulls the cutting tools and blades used by buyers in further processing and causes other problems.

Growing tightness in the supply of wood fibre within North America raises the prospect that alternative fibres, such as fescues, wheat straw and industrial hemp, might become commercially viable as these trends evolve. However, as noted later, the success of these alternative fibres to date in the manufacturing of composite boards has not been encouraging.

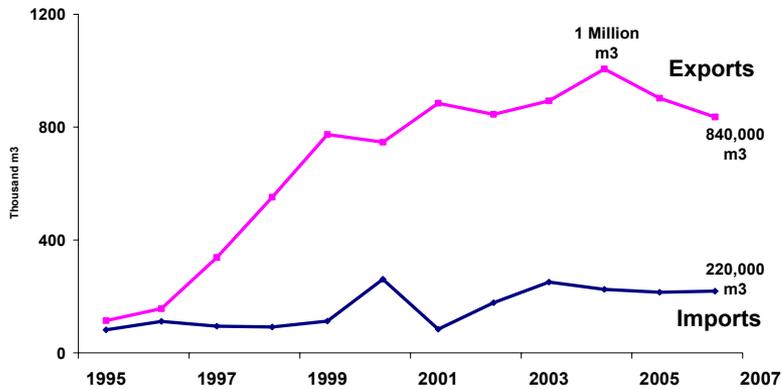
MDF and Particleboard Trade

There is a strong linkage between the US and Canada in MDF trade. The US is a significant net importer of MDF, importing 1.4 million m³ in 2006 (Exhibit 29) before declining to lower volumes in 2007 and 2008 – in response to the downturn in the US housing and furniture demand.

Canada is a significant net exporter – it imports some grades not produced extensively by its domestic industry, or where imports are more competitive. Overall, it exports in the ratio of 4:1 compared with imports.

MDF: Canada is a Significant Net Exporter

Exhibit 29



Source: FAO Stats

[1] "Price-advantaged" refers to products, such as bio-fuels, which receive government subsidies in some consuming countries (e.g. Europe in the case of wood pellets) – or for which regional economic development incentives are provided in supplier countries – and which therefore are financially enabled to bid higher than normal market prices for raw materials and other resources.

[2] Example, BC Hydro in British Columbia

Market Opportunities: Hemp Boards (Low and Medium Density)

MDF and Particleboard Trade (continued)

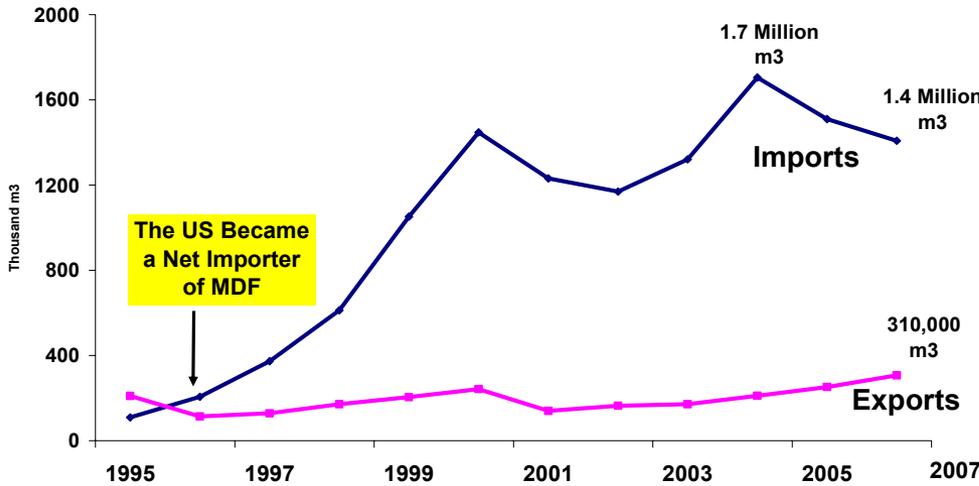
These net trade positions are reflected in bilateral trade between the two countries. Canada is by far the largest supplier of MDF imports into United States – accounting for a 43% share of all suppliers in 2007, and a 49% share of the ‘Top 7’ suppliers (Exhibit 30). Chile was #2, with 24% of the ‘Top 7’ volume in 2007.

Canada as a Potential Exporter of Hemp Boards to the United States?

A significant aspect of Canada-US trade is exchange rates. Between the mid-1970s and the early 2000s, Canada’s weaker dollar in U.S. funds provided a substantial currency-induced competitive edge for Canadian shippers of goods to the United States (Exhibit 31). Between 2002 and 2008, this competitive advantage eroded rapidly as the Canadian dollar strengthened against the U.S. dollar. In early 2009, it weakened again. Generally, it is very risky to depend on exchange rate differentials for a competitive advantage in U.S. markets. Where a fundamental trade advantage (such as low U.S. self-sufficiency, as in the case of particleboards and MDF) also exists, the business case for considering the US market may become much stronger. This suggests, from an export market opportunity perspective, the US market may be a market for hemp board producers in Alberta to consider. This assumes that costs of production in Canada can be competitive with other supply regions.

Exhibit 31

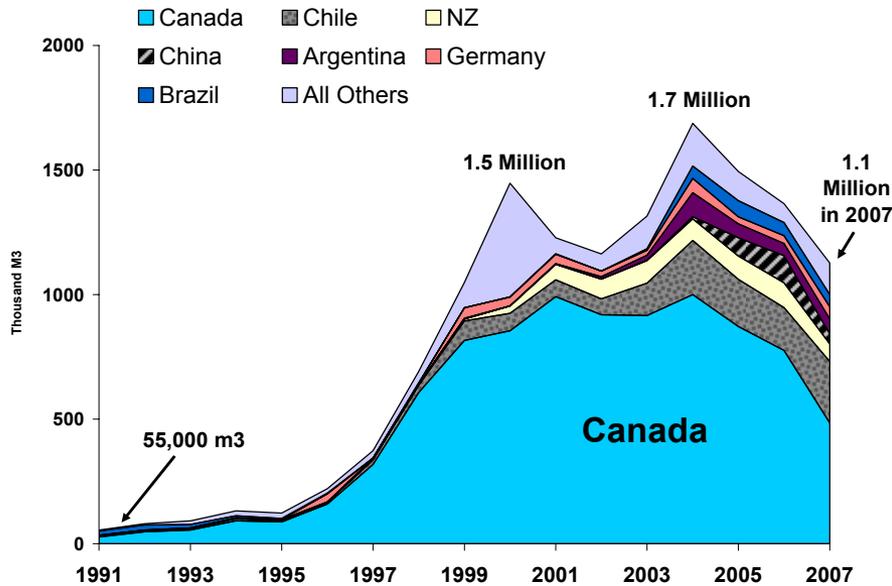
MDF: The US is a Significant Net Importer



Source: FAO Stats

Exhibit 30

US Imports of MDF - Volume



Data Source: US Trade Data FAS

Market Opportunities: Hemp Boards (Low and Medium Density)

MDF and Particleboard Trade (continued)

An opportunity for Canadian exporters of hemp boards to sell in the U.S. could emerge over the longer term.

To date, China has been a very small supplier of MDF to the US. Total exports of MDF from China to all world markets have been rising (Exhibit 32). These totaled 700,000 m³ in 2006, compared with its reported production of 22 million m³. This was about 3% of China's total output of MDF. Not long ago, many reports indicated that China could become a significant exporter of MDF to the U.S. market. Moreover, until recently, new capacity in MDF continued to be added within China. With the 2008/09 sharp downturn in world trade, and with recent shifts in global log export markets (Russia's log export restrictions) and fibre flows, however, it seems more likely now that this is a lower risk for new suppliers of competing composite boards to the United States.

Although China may continue to be an exporter of raw MDF boards (and particleboards) to world markets, the opportunity cost of these exports will continue to rise. China's fiber costs, resin costs and labour costs are increasing on a per unit basis (although the latter are comparatively low globally). More likely than raw board growth is an increase in high-end furniture in which China has a competitive advantage –and which meets its goals of value-added manufacturing.

Particleboard

Much of the analysis presented above is valid also for particleboard. However, in this product, Canada is even more of a significant supplier to the United States – and accounted for over 80% by volume of US imports of particleboard in 2007.

Canada's exports to the US have been declining, as (like MDF) more of this product is consumed in its recently buoyant domestic markets. As a result, there has been a decline of nearly 40% in Canada's volume exports in particleboard to the US since 2004 (and a 52% decline in MDF shipments to the US).

These are contributing factors to the recent raw materials shortages of certain grades reported by some buyers and rising prices noted already.

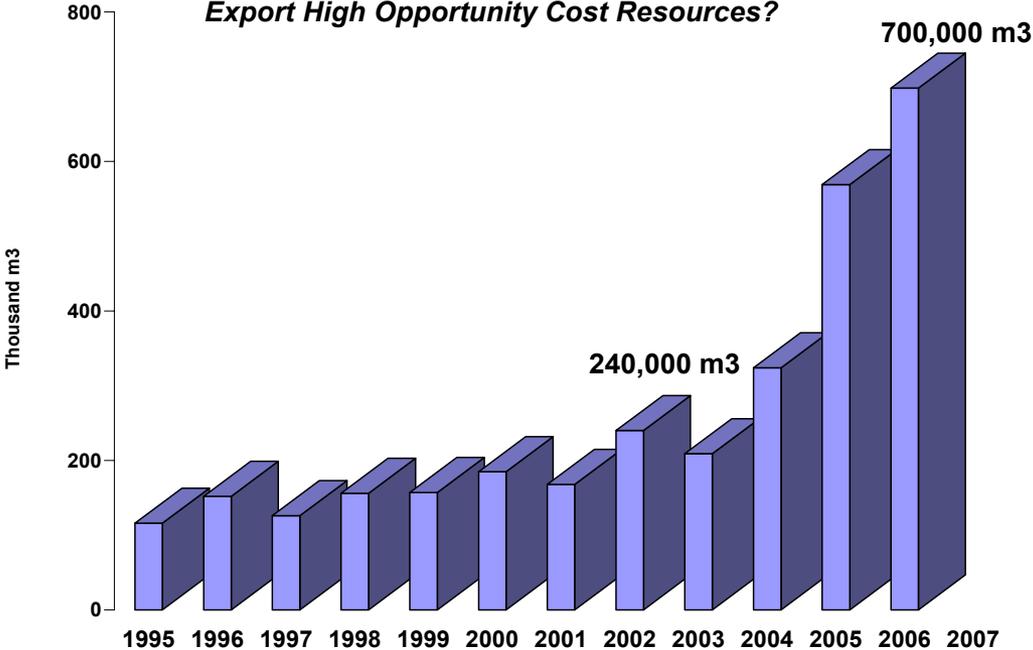
We do not feel that this evolving and uncertain situation will create an immediate opportunity for Canadian exporters to the U.S. of, for example, hemp boards. But an opportunity of this type could emerge over the longer term.

Again, much will depend on how price –and quality – competitive hemp boards can become in relation to particleboards and MDF.

Exhibit 32

China's Exports of MDF to World Markets

Gathering Strength, But Can China Afford to Export High Opportunity Cost Resources?



Data Source FAO Stats

Market Opportunities: Hemp Boards (Low and Medium Density)

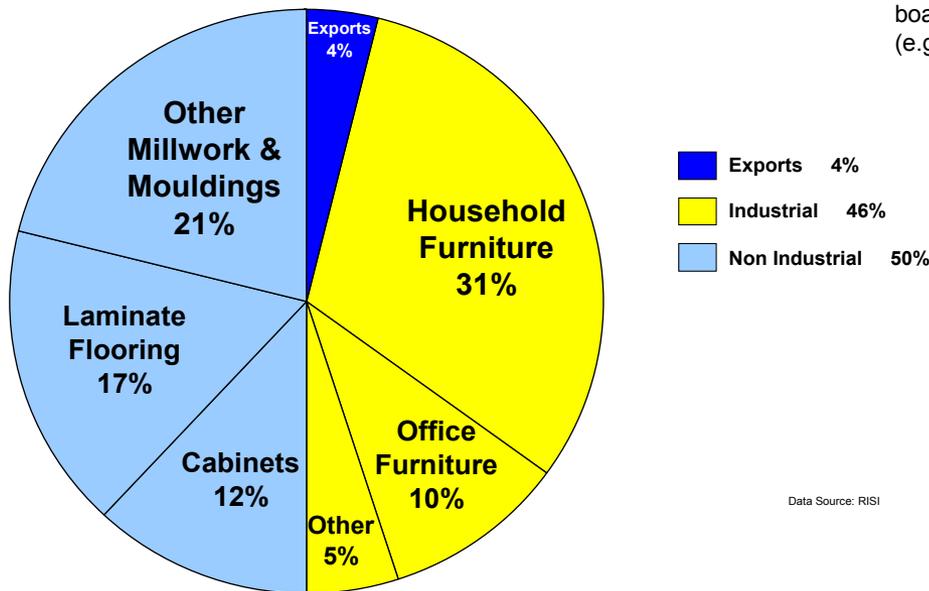
Hemp Boards: Potential Market Share

The potential scope for market share gains by hemp boards can be illustrated by reference to Exhibit 33. We estimate the total market in North America for MDF and particleboards at around US\$9 Billion in 2008, of which particleboards were U.S.\$7.4 Billion. As noted earlier, production growth rates are more rapid for MDF.

This shows the end-use market segments of MDF consumption in the U.S. Industrial uses account for around 46% of consumption –comprising furniture applications (41%) and other uses (5%) into which hemp boards most likely would fit. Non-industrial uses comprise 50% of total U.S. consumption – comprising cabinet manufacturing, laminate flooring (thin boards) and other millwork and mouldings (into which hemp boards also might fit). These data suggest, at the outset, that hemp boards would fit into a comparatively small segment of the market. Based on the data provided, this would be an aggregate market of up to 26% of total U.S. consumption – of which hemp boards (focused on light board markets) would supply only a small fraction. On a preliminary basis, we estimate this as being, at most, a U.S.\$200 million per year market at the present time.

U.S. MDF Consumption - by Sub Sectors

Exhibit 33



Data Source: RISI

Laminating Potential

Hemp boards have potential as substrates for laminating. They are marketed for this purpose in Europe (Exhibit 34). In addition, they can be produced as thick boards, which is a specialty market not served by many producers in North America (e.g. Great Lakes Fibreboard produces thick boards with its steam press).



Woodbridge Associates photo: Courtesy of Gary Newman



Market Opportunities: Hemp Boards (Low and Medium Density)

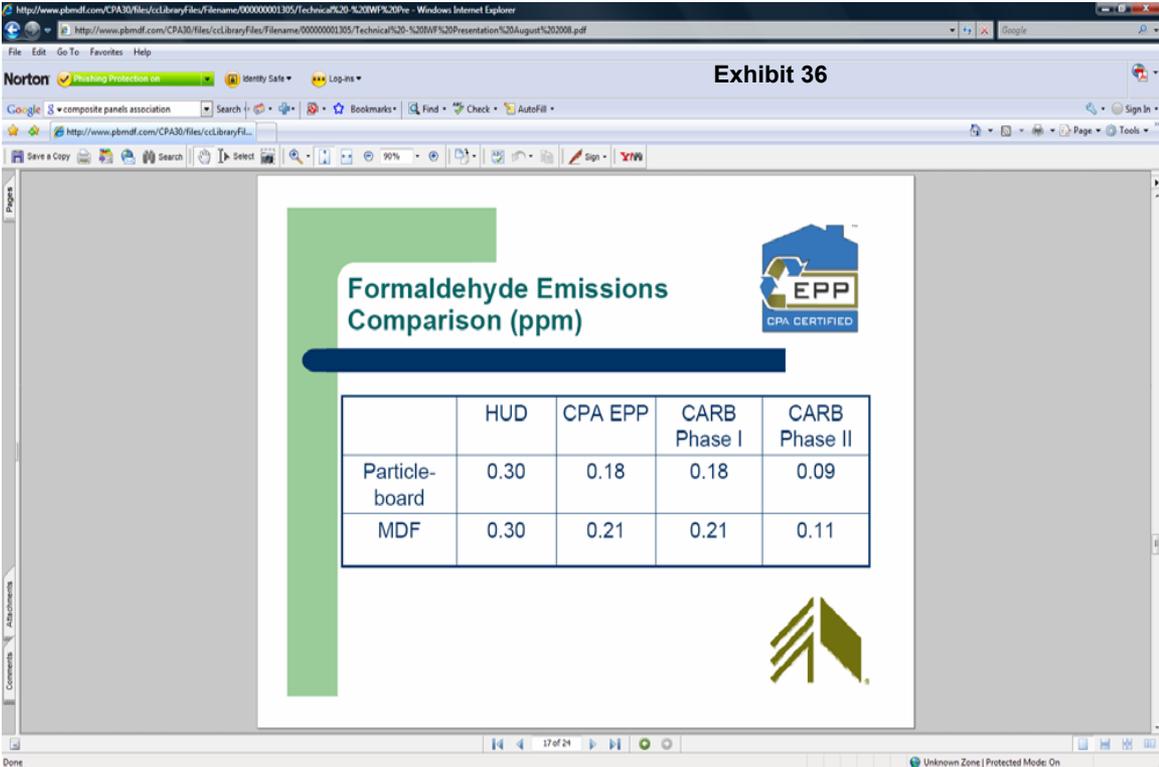
Hemp Boards: Other Potential Niche Markets in North America

Our research indicates that particleboard and MDF, and in some applications hardboard, appear to serve most markets for composite, non structural boards in North America. In Europe, loft (attic) boards are one of the niche markets served (Exhibit 35). A potential market in North America could emerge because of concerns about formaldehyde 'off-gassing'. In the U.S., California has introduced its CARB Air Toxic Control Measure for Composite Wood (April 2007, finalized March 2008). Phase 1 of these measures begin

The response of several particleboard and MDF producers has been to produce 'no UF added' boards (Exhibit 36). As a result of the new legislation, permanent closure of marginal particleboard plants could occur. This could be a growth opportunity for industrial hemp board producers.



Woodbridge Associates photo: Courtesy of Gary Newman



Source: Composite Panel Association

Market Opportunities: Hemp Boards (High Density)

Automotive components containing renewable raw materials (including hemp, flax and abaca) is 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 (Exhibit 37, 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 include BMW, Volvo and Fiat-Renault. The Opel Astra (General Motors) uses flax felt mats. Flax also is used for headliners and rear parcel shelves used for the Renault Twingo. 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 is reported to be working on including these fibres in its interior components.

The composite material is heated up and pressed into a three-dimensional moulded components (Exhibits 38-39). ATA estimates that the global composites industry is worth around 53 billion Euros annually. Natural fibres are a small part of this total at present, but demand is growing rapidly because of the demand for earth-friendly, strong non-woven fibres.



Exhibit 37

Mercedes A-Class

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 to the automotive sector. Source: ATA



Exhibit 38

Woodbridge Associates photo: Courtesy of Gary Newman



Exhibit 39

Woodbridge Associates photo: Courtesy of Gary Newman

Market Opportunities: Hemp Boards (All Densities)

Conclusions

Low and Medium Density Hemp Boards

- Markets for composite boards in North America cover a wide variety of products. It is estimated that these markets are growing in aggregate at around 5.3% per year for particleboard and around 8.8% per year for MDF. Hardboards markets are growing at a very slow rate. We estimate the aggregate market value for particleboard and MDF in North America at U.S.\$9 Billion, in 2008 – of which particleboard is over 80%.
- Alternative fibres used in the production of low density and medium density hemp boards (including strawboard) have a market share of considerably less than 1%. Hemp boards do not have a market share at the present time.
- Compared with existing products which appear to be serving the marketplace well, low and medium hemp boards do not readily stand out as having exceptional unique selling points (USPs). They have several worthwhile properties, including their light weight – which makes them suitable for specialized markets such as fittings inside aircraft and boats (where weight is an issue). In addition, they are ‘green’ products, but the same is being claimed for particleboard and MDF.
- There seem to be some potential markets that could provide promising developments over time. These include ‘no urea formaldehyde added’ and ‘no phenolic formaldehyde added’ boards. Formaldehyde occurs naturally in nature, and UF free boards would be difficult to produce. Strong anti-formaldehyde legislation has been introduced in California (‘CARB Measures’) and seems eventually destined to be adopted at the federal level in the United States. As a result, particleboard and other producers are producing and selling ‘no UF added’ boards.
- The most promising opportunities for low and medium hemp board growth, and market share gains, appear to be related to the growing shortage of wood fibre in North America, and its rising cost. In the past these factors have stimulated considerable interest in composite boards made from alternative fibres –including wheat straw. However, as noted in more detail in the next section, many of the composite board manufacturing ventures based on agricultural fibres have not been successful to date.
- Within a decade, timber supply within North America may change sufficiently (as we believe it will) for alternative fibres to become a viable consideration in the production of composite boards. At that time, we expect, existing major players in the composite board industry are likely to become producers. For the immediate future, we estimate a very small niche market for low and medium density hemp boards.
- The total market, within which low and medium hemp boards would have to compete with wood-based particleboards, probably is valued today at no more than U.S.\$200 million per year. We conclude that, while quality hemp boards (of the type produced in Europe) also can be produced technically well in North America, the markets for them are very limited at the present time. Moreover, we can see no reason why a sustainable price premium (above particleboards) could be expected for hemp boards.

High Density Hemp Boards

- 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. This is encouraging for growers and processors because of the scale of potential demand –and the research focus – of this sector globally.
- The automotive sector in North America (following the lead of European automakers) has identified natural fibres, and composites containing natural fibres, as being a growth segment for new supply. This sector’s demand is based on the rapidly emerging needs for eco-friendly, high strength and safe non woven fibres and reinforcing fibres.



5.

**Product Manufacturing:
Hemp Insulation & Hemp Board**

Woodbridge Associates photo: Courtesy of Gary Newman

5. Product Manufacturing: Hemp Insulation & Hemp Board

Focus of Business Case Analysis

The focus of this business case analysis for **hemp insulation** and **hemp boards** is on the market drivers that may create a commercial proposition for hemp growers and processors in Alberta. The business case for manufacturing these products is the main focus of this section. Literature relating to technical requirements in manufacturing is available in the public domain and is not the focus of this report.

From the previous section, our conclusions derived from market acceptance, competitiveness assessment and growth in demand analysis, indicate the following:

Manufacturing of Industrial Hemp Insulation:

- We believe that this is a potentially viable product for Alberta growers, processors and hemp insulation manufacturers.
- It must (in our view) be produced in state-of-the-art manufacturing facilities and achieve low units costs that will allow it to compete – price-point for price-point – against fibreglass insulation.
- We recognize that industrial hemp insulation has several unique selling points (USPs) in relation to existing products in the marketplace. In particular, as a potentially net zero carbon product, made from natural fibres, hemp insulation produced in commercial quantities, and if made widely available, can win significant market share – as noted, mainly from fibreglass insulation. It can also win market share from foamed plastics and newsprint-based cellulose insulation products. But the latter should not be the producers' and distributors' main targets.
- It would be an error, in our view, to assume that hemp insulation should be launched as a niche product priced at a premium to fibreglass. As a niche 'green' product, marketed at a price premium, the market share potential for hemp insulation will be limited. Except for 'planet issue' conscious buyers, we predict that – if it is marketed this way – consumer acceptance will be low. In a more practical sense, and perhaps commercially more to the point, it would fail (as a small scale, niche green product) to gain vital support from building code specifiers, architects and builders.
- In effect, industrial hemp insulation (as far as the North American market is concerned) is a promising new product that has significant growth potential. But its Achilles Heel is that early stages of growth in manufacturing could, as the saying indicates, "fall between the devil and the deep blue sea". Unless it is produced from the outset on a commercial scale, targeting itself as a superior product – but at a competitive selling price with existing dominant products in the marketplace, it risks developing a permanent reputation as a 'fad' product. Competitors will be eager to reinforce this niche image.
- This is not a marketing strategy that is well-heeded in Canada or the U.S. For potential hemp growers, processors and hemp insulation manufacturers, a useful analogy is the demand for Japanese and German cars compared with North American cars. A large body of independently-produced literature exists to show that, over the past 20-30 years, Japanese and German cars have gained substantial market share gains in North America because car buyers believe that they are better quality vehicles. Despite this 'quality premium', the "imports" are priced competitively with North American cars. "Import "car manufacturers recognized at the outset that they risked becoming a niche market had they priced-in a 'quality premium' to their product. Instead, by pricing their vehicles competitively, and focusing their manufacturing efforts on generating profits through productivity and unit cost reductions, they have succeeded (see 'Toyota business model references available on the iNet). We believe that this must be the marketing and manufacturing business model for the emerging industrial hemp insulation industry in North America – if it is to achieve its full potential.

5. Product Manufacturing: Hemp Insulation & Hemp Board

Exhibit 40



5. Product Manufacturing: Hemp Insulation & Hemp Board

Manufacturing of Hemp Board

From the previous section, our conclusions derived from market acceptance, competitiveness assessment and growth in demand analysis, indicate the following:

- The **manufacturing of low and medium density hemp boards** in Alberta is a very marginal proposition at the present time, in our view.
- Production could be considered only as part of a larger complex producing other hemp products, where a processor may be able to achieve an additional by-product revenue stream – but where other hemp-based manufacturing enterprises create the mainstream earnings necessary to meet the threshold rates of return required for the overall processing/manufacturing complex. We believe that hemp oilseeds and hemp fibre production should be the priorities.
- If industrial hemp processors in Alberta decide to proceed with an investment in manufacturing of low and/or medium density manufacturing hemp boards, within the next five years to the year 2013, we would strongly recommend that they minimize their capital risks by utilizing existing former wood particleboard mill facilities or equipment.
- There is a reasonably high probability that, within the next five years, shifts in North American timber supply balances (linked to a sharp decline in softwood lumber production in western Canada and Quebec) will create substantial residual fibre deficits for wood particleboard (chipboard) producers. In addition, wood costs are expected to rise in real terms. This may create conditions conducive to the construction of a modern, state-of-the-art leading technology board manufacturing plant using agricultural fibres. The viability of low and/or medium density panel production will depend on the economics of the time.
- To date, strawboard and other agricultural fibre based production plants designed to manufacture low and/or medium density composite boards have not been financially successful (see further details in this section). Their lack of success frequently is attributed to (a) product quality – notably low and inconsistent quality fibre supplies (b) lack of any unique and commercially valuable properties in the composite boards produced (c) high unit costs of production compared with various particleboards and MDF and (d) lack of forward integration channel links – which are an essential feature of the successful business models pursued by leading firms in the composite boards manufacturing industry in North America.
- The long fibres from the outside of hemp stalk potentially could position industrial hemp as a source of reinforcing fibres for composite boards – just as they are highly prized as bio-fibres for interior trim parts in cars (see further details in this section). But it should be remembered that flax, which is grown more extensively, also can provide parallel properties in this regard – and (quality for quality) buyers will be seeking the lowest cost reliable supplies of consistent quality fibre.
- We conclude that, for the foreseeable future, hemp growers and processors in Alberta should not rely on sales to low and/or medium density hemp board manufacturers for the viability of their commitments to this crop. However, **the use of hemp fibres in high density composites** (notably for the automotive sector) appears to be a very attractive, and potentially profitable proposition – but should be researched further to establish the economics involved and the availability of contracts for growers with essential channel partners in processing and the end-use market.
- In high density composite board manufacturing, AFT Plasturgie located at Dijon, France, is a good example of a producer focused on high-end automotive industry markets.

5. Product Manufacturing: Hemp Insulation & Hemp Board

Hemp Processing Facilities

Virtually 100% of the industrial hemp plant can be utilized. When it is received from the grower (see 'market-driven focus', below), industrial hemp can be channeled by the processor into several different product streams. Excluding the use of the whole plant for products such as ethanol (alcohol), the major products include the following:

Hemp Seed ('Grain') and Flowers

Edible Oils

8 essential proteins and 3 essential fatty acids [EFA]: low in saturated fats. The oil is of high nutritional value because its 3:1 ratio of omega-6 to omega-3 EFAs, which matches the balance required by the human body (source: Wikipedia)

Industrial Oils

- Plastics
- Paints
- Cosmetics, soaps and pharmaceuticals

Rendered Hemp Grain

Feedstuffs (human and animal protein)

Hemp Fibre (Derived from the Stalk or 'Straw')

Bast (higher end fibres: primary bast is long and low in lignin; secondary bast is intermediate fibre length and high in lignin**)

- Paper-making
- Fibreboards
 - Low and medium density
 - High density (reinforcing fibres in eco-friendly applications, along with personal safety end-uses)
- Insulation
- Clothing, carpeting

Hurds/Core (typically lower end-uses)

- Animal bedding
- Concrete ('Hemcrete' trademarked in Europe)
- Bio-fuels

** source: BCMAF Industrial Hemp factsheet

Market-Driven Focus

We have emphasized in this report that a market-driven focus (Exhibit 41) is the best and potentially most sustainable approach to processing and growing economics. The markets within which each of the above products "fit" are very large. Existing manufacturers are well-established, and developed supply-chains and relationships are in place. Barriers to entry can affect the ability of a 'new' product –such as a manufactured product from industrial hemp – to enter the market and gain sufficient market share to become financially viable. Industrial hemp products can become large scale production items – but ultimately they have to relate to a specific market need and fit into specific price points within these markets.

Market-Driven Focus is Essential for Processors and Growers

Exhibit 41



5. Product Manufacturing: Hemp Insulation & Hemp Board

Potential Revenue Streams for the Hemp Grower and Processor

Hemp Oil Seed

According to a leading trade group, the Canadian Hemp Trade Alliance (CHTA), as noted by Rawson, the harvesting, shelling and processing technologies for conventional oilseed crops in Canada are suitable for handling hemp grown for seed. This has enabled acreage to expand as soon as markets are found. Farmers who obtain organic certification for their hemp seed receive premium prices (Rawson, ibid). Further analysis of the manufacturing economics relating to hemp oilseed products is outside the scope of this report. Readers are referred to the Internet and other sources for this information. However, it is relevant to this report to note that the Canadian market for hemp oilseeds is comparatively well developed –and that revenue for oilseed sales is an important potential source of income for the grower and contracting processor.

Bast and Hurd Fibres (Exhibit 42)

A working knowledge of each of these groups of fibres, and their respective market potential, is important for growers and a detailed knowledge is essential for processors.

Bast Fibres

Historically, industrial hemp was known for its bast fibre – used to make strong, but coarse, fabrics and ropes. Today, these are a source of fibres used in a wide range of applications where hemp’s long fibres are valued such as papermaking, fibreboards, insulation, clothing and carpeting.

Hemp use in paper-making fills a high value, but comparatively small and specialized market niche at the present time. It is used for cigarette papers and other specialty papers. Wood cellulose dominates the papermaking industry. It is considered unlikely that industrial hemp grown in Alberta could develop a significant market for use in the papermaking industry.

Fibreboards and insulation end-use markets are the focus of this report.

Hurds/Core

These are the non-fibrous or woody inner layer of the stem (see Section 6 for details). These go into lower valued markets, in products such as animal bedding and bio-fuels (which recently have risen in price). They also can be used for building materials, notably concrete and various concrete block products.

With focus on evaluating the business case for growing industrial hemp in Alberta for manufacturing hemp boards and hemp insulation, the two revenue streams of principal relevance to this report are (a) bast fibres and (b) oilseeds.



5. Product Manufacturing: Hemp Insulation & Hemp Board

Bast Fibre Manufacturing for the Non Woven Fabric Market

Non-wovens are fabric-like materials made from long fibres. They are bonded together by chemical or mechanical means – and the manufacturing process may involve a solvent or heat. Non-woven fabrics, by themselves, may lack sufficient strength but typically can have a reinforced backing or they may be densified. Historically, non-wovens have been closely associated with fabrics, such as felt, which are neither woven nor knitted (source: INDA http://www.inda.org/category/nwn_index.html). Today, however, non-wovens cover a wide and diverse group of products used in medical and hygiene applications; filters and geo-textiles; staple and spunlaid non-woven fabrics and other comparatively high valued products (source: Wikipedia). Benign, 'earth-friendly' applications are immense. Some uses noted by Wikipedia (Exhibit 43) include the following.

Non-Wovens Relevance to the Hemp Fibre Manufacturing Industry

As noted elsewhere in this report, industrial hemp manufacturing – in its modern context – is an “infant industry”. It is still in the very early stages of development.

As such, having several globally large scale complementary industries aligned to it could be of substantial benefit to the industrial hemp processing industry. Benign industrial fibres such as these can provide solutions for other manufacturing activities, industries including for example the North American automotive sector, along with the global non-wovens sector and, potentially, the 'green-built' insulation sector (Exhibit 44). Separately, or together, these potentially could provide a major boost to the rapid industrialization of industrial hemp.

The benefits could accrue through factors such as the typically strong research and development (R&D) focus of these leading industries. With operating conditions (such as the need for net zero carbon emissions) changing and consumer preferences (e.g. demand for 'green' products) shifting, the long and strong fibres provided by industrial hemp are becoming sought after by these sectors.

Moreover, with very large scale manufacturing operations in their own product range, a switch in raw material preferences in favor of benign industrial fibres, such as industrial hemp, could provide the impetus for large scale processing facilities – and an in flow of investment support.

Technologically, having these types of sectors aligned to an emerging 'infant industry' such as industrial hemp could provide the technical support required to ensure that an efficient and highly productive supply-chain is put in place from the outset. Pilot testing facilities within Alberta (and R&D dollar support) designed to improve the fibre qualities required by the end-using industry, could become a high priority for firms in these aligned sectors.



<p>Hygiene Baby diapers Feminine hygiene Adult incontinence products Wipes, bandages and wound dressings</p> <p>Medical Isolation gowns Surgical gowns Surgical drapes and covers Surgical scrub suits, caps</p> <p>Filters Gasoline, oil and air - including HEPA filtration Water, coffee, tea bags Liquid cartridge and bag filters Vacuum bags Allergen membranes or laminates with non woven layers</p> <p>Geotextiles Soil stabilizers and roadway underlayment Frost protection Agricultural mulch Pond and canal water barriers Sand infiltration barriers for drainage tile</p> <p>Other Carpet backing, primary and secondary Marine sail laminates Tablecover laminates</p>	<p>Exhibit 43</p> <p>Source: Wikipedia</p>
--	---

5. Product Manufacturing: Hemp Insulation & Hemp Board

Other Non-Wovens Revenue Potential

Other non-woven products support the potential for an industrial hemp fibre processing facility located in Alberta – and provide potential diversification for the type of large scale processing plant envisaged. These include hemp fibre mats (Exhibits 45 and 46) used in the automotive sector, and similar products used in a wide range of geotechnical applications including soil stabilization, water barriers in ecologically sensitive locations and sand infiltration barriers for drainage tiles and to prevent the passage of waterborne large particles.

Exhibit 45

Exhibit 46



Woodbridge Associates photo: Courtesy of Gary Newman



Woodbridge Associates photo: Courtesy of Gary Newman

5. Product Manufacturing: Hemp Insulation & Hemp Board

Manufacturing Particleboard and Low Density Hempboard

The manufacturing process for low density hemp board is virtually the same as for wood cellulose particleboard (Exhibit 47). In fact, older particleboard capacity sometimes is used to produce low density hempboards (e.g. Kosche in Germany). The process is as follows. To achieve the desired particle geometry, raw material must first be cleaned and sized, then mechanically resized by means of a refiner and a series of screens. Once sized, the material passes through a dryer and then to a storage silo. Urea formaldehyde (UF) resin is applied prior to forming the mat. (Additives to enhance characteristics like fire retardancy or moisture resistance can be applied at this stage). Mats are then formed on a caul plate or belt, loaded into the press and subjected to heat, pressure and time until the resin has cured. After the press cycle is complete, the panel is removed from the press, transported through a board cooler, and then hot-stacked to await sawing into finished panel sizes and sanding. (source: McGraw Hill Construction Continuing Education Centre). Increasingly, particleboards are having to compete for fibre with bio-fuels (Exhibit 48).



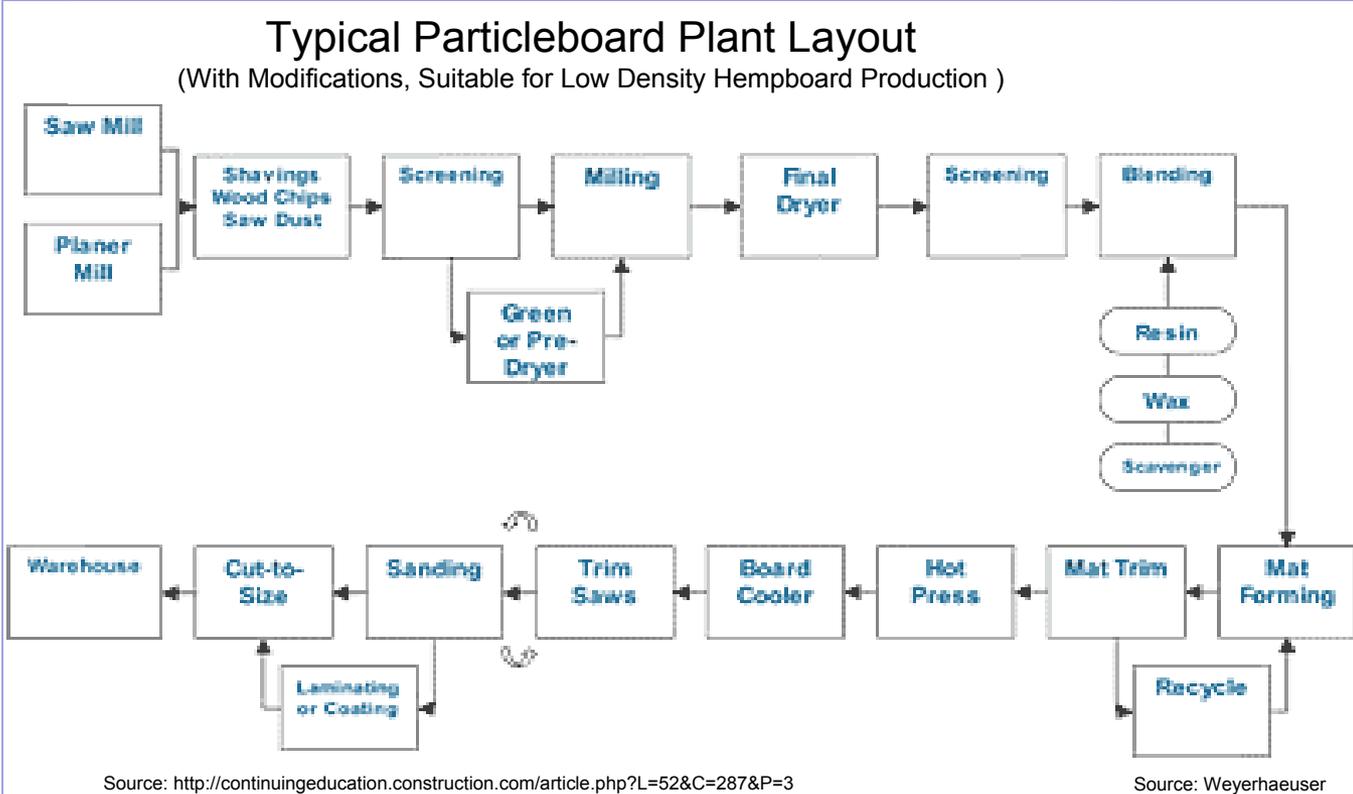
Woodbridge Associates photo: Courtesy of Dr. Gary Newman

Exhibit 48



Rising bio-fuel values are creating competition for wood cellulose and industrial fibres

Exhibit 47



5. Product Manufacturing: Hemp Insulation & Hemp Board

Lack of Commercial Scale Bast Processing Facilities in Canada

The lack of commercial scale bast fibre processing facilities in Canada has been identified by the authors of the country’s ‘National Industrial Hemp Strategy’ as being a primary barrier to growth. It was pointed out by the authors that the production of sufficient commercial quantities of high quality bast fibre and hurd is required to enable the development of downstream applications.

*“The lack of commercial scale bast fibre processing facilities in Canada is a primary barrier to growth”
– National Industrial Hemp Strategy (March 2008)*

Several other important manufacturing shortcomings were also identified. They include the lack of broadly available test methods for specific product applications, and the need for fibre grading standards.

Production Economics

Alberta Study (Year 2000): An assessment by Alberta Agriculture ([www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex126](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex126)) in the year 2000 noted that, since little hemp has been harvested in Alberta, cost information is difficult to obtain. The Alberta Agriculture analysis provided an estimate of the basic expenditures required to operate a 20 hectare (50 acre) industrial hemp operation in Alberta, and the ministry’s estimates are summarized below (Exhibit >). The operation size of 20 hectares defined by the Ministry is based on the (assumed) need for growers to “start small, but also operates at a size that gains some economies of scale”. The use of custom operators (outsourcing) of some operations (presumably harvesting) is assumed in order to minimize equipment costs. Stalks (straw) production in this example is assumed at 3 tonnes per acre (~7.5 t/ha) and seeds production at 500lbs per acre (1,235 lbs/ha). The Ministry noted that yields and product prices have the greatest impacts on financial performance of the operation. Accordingly, it provided sensitivity analyses with seed yields ranging from 300lbs per acre (740 lbs/ha) to 700lbs per acre (1,730 lbs/ha) with a range of seed prices. Stalk (straw) prices were assumed at C\$30/t and seed at C\$0.50/lb. As noted in Exhibit 49 below, the Ministry calculated a net operating loss for this enterprise based on the assumptions as outlined.

Exhibit 49

20 Hectare (50 Acre) ‘Start Small’ Dual Prod’n Operation

Item	Quantity	Amount C\$
Hemp Seed & Stalk Revenues	25,000 lbs + 150 tonnes	19,500
Seed, Fertilizer, Other Costs		8,150
Machinery		13,130
Licensing/Other		2,500
Total Operating Expenses		23,780
Fixed costs		3,891
Net Operating Income		(8,171)

Source: Based on ARD Example (higher revenue case, Table 4

Ontario Study (Year 2000): In the same year, a study by Ontario’s Ministry of Agriculture, Food and Rural Affairs (<http://www.omafr.gov.on.ca/english/crops/facts/00-067.htm>) indicated actual prices paid to the grower in Ontario for hemp stalks (straw) ranging from C\$70-180 per tonne. However, it cautioned that there were no reliable price or quality indicators available at that time – and strongly advised potential growers to secure a contract with a reliable firm. We echo that advice in this report.

Manitoba Guidelines (Year 2009): In 2009, the Province of Manitoba published its ‘Guidelines for Estimating Crop Production Costs’ (<http://www.gov.mb.ca/agriculture/financial/farm/software.html>) which indicated assumed market prices for hemp stalk (straw) of C\$110/t and seed at C\$0.55/lb. The Guidelines indicated crop production costs and fixed costs that are helpful to potential growers in calculating their breakeven levels. Breakeven yield levels of 2.3t/acre (~5.8t/ha) for hemp stalks (straw) and 468lb/acre (~1,155lbs/ha) for oilseeds were indicated based on the assumptions provided.

Commercial Growers’ Websites: A review of Canadian growers’ websites (e.g. Parkland Industrial Hemp Growers Co-op www.pihg.net) did not reveal any current price information.

Agricultural ministries “strongly advise potential growers to secure a contract with a reliable firm” and carefully carry out their own economics calculations before proceeding.

5. Product Manufacturing: Hemp Insulation & Hemp Board

Exhibit 50



5. Product Manufacturing: Hemp Insulation & Hemp Board

Production Economics (continued)

Hemcore (UK)

Hemcore, located in England, is a leading edge processor of industrial hemp (www.hemcore.co.uk). The company works closely with growers and other processors and final manufacturers in developing the dual crop industrial hemp industry and it has successful commercial operations within Europe. Its website provides useful current information for the 2009 growing season. UK prices and cost information are not directly applicable to Canada, and yield indications and other assumptions may not apply to Alberta conditions. Moreover, exchange rate fluctuations can cloud the meaningfulness of these data.

At Hemcore, the hemp seeds are cold-pressed for human consumption by a third party processor and the hemp stalks (straw) are processed by Hemcore into the range of products indicated on its website. These may not exactly coincide with the products and markets of interest to potential growers in Alberta. In addition, transportation and other costs per unit are unlikely to be the same in both jurisdictions. The average size (acreage under hemp) of growers working with Hemcore is not known, but the Company recommends that only growers interested in contracts for 10 hectares and above should apply. For estimating purposes, Hemcore assumes three examples of potential U.K. crop yields of 6t/ha; 8t/ha and 10t/ha respectively.

At the lower end, these are in line with the western Canadian crop yields assumptions noted previously. At the higher end, they are more in line with what we believe may be necessary in Alberta for industrial hemp to become established as a **sustainable** commercially successful (seed and fibre) producer serving, in particular, the hemp insulation market opportunity noted earlier. This also anticipates the need to optimize economies of scale in Alberta because of the potential for eventual competition from producers in the U.S. For oilseeds, Hemcore assumes U.K. yields of 2,650 lbs /ha

“In good years [in the U.K.] yields of 9 tonnes per hectare have been achieved but an average of 7.5 tonnes per hectare is more likely”. source: Hemcore website www.hemcore.co.uk

In the business cases presented in this report, we believe that a larger scale industrial **dedicated** hemp fibre growing operation (or syndicate/co-op) would be required to support the state-of-the-art (SOTA) processing and manufacturing facilities envisaged.

In order to make this work, higher revenues (than those shown on the previous page for Canadian operations) are assumed from the sale of seed, high quality bast fibres and hurds. Unfortunately, as noted, current actual Canadian data or estimates for this revenue are not easily obtained.

For the purposes of illustrating the revenue that most likely would be required from the production of high quality fibre stalks (straw), and to demonstrate the order-of-magnitude ‘economies of scale’ unit cost reductions that may (or may not) be possible from a dedicated high-yield larger scale hemp fibre growing operation, we provide (Exhibit 51) a hypothetical example called ‘SOTA Operation’. It should be noted that considerable further work is required on these preliminary estimates. However, it appears that the enterprise potentially could be financially viable. Comparatively high hemp stalk (straw) yields of over 9t/ha but modest seed yields of ~1,550 lbs/ha are assumed (i.e. it assumes the grower will optimize for fibre).

Exhibit 51

Alberta SOTA High Yield Operation: 80 Hectare (~200 Acre)

Item	Quantity	Amount C\$
Hemp Seed & Stalk Revenues	125,000 lbs + 750 tonnes	162,500
Seed, Fertilizer, Other Costs		30,000
Machinery (assume SOTA)		75,000
Licensing/Other		5,000
Total Operating Expenses		110,000
Fixed costs		10,000
Net Operating Income		42,500

Source: Woodbridge Associates Inc.

Conclusion: In relation to the market opportunities noted in this report, large scale, high yield enterprises (capable of generating low unit costs) will be essential if **industrial hemp fibre growing** is to be a viable & sustainable activity for growers in Alberta.



5. Product Manufacturing: Hemp Insulation & Hemp Board

1. False Starts in Processing

Hemp

The surge in the area under industrial hemp cultivation in Canada, which began immediately after the first growing permits were issued in 1998 (see next section), also raised expectations among growers of a potentially very profitable alternative crop. Among processors with significant expectations, a U.S.-based firm named Consolidated Growers and Processors (CGP) was formed in 1997 and floated on the over-the-counter (OTC) stock market in the United States, with a view to strengthening its role as the world's first multinational industrial hemp company (source: <http://composite.about.com/library>).

CGP envisaged developing global supplies of industrial hemp, soon after the growing ban in Canada had been lifted, and focused on potential growers in Canada, Europe and Australia. A range of products was envisaged by the firm, including pressed oil, building insulation, automotive parts, currency and security paper and geotextiles. CGP indicated that it intended, by the end of 2003, to plant 500,000 acres and build 20 processing facilities in three primary growing regions. CGP filed a voluntary petition for bankruptcy in March 2000. In Manitoba, where CGP said it intended to build a processing plant, numerous farmers signed contracts to grow industrial hemp to supply the promised processing facility. When the facility failed to materialize, the farmers were left with fibre and grain from approximately 12,000 acres (source: www://pihg.net website).

Strawboard Plants

Within North America, there have been numerous failures among low density board plants based on alternative fibres. One example is the plant at Wanham, Alberta. Located about 90 km northeast of Grande Prairie, Alberta, the Wanham plant was built at a cost of \$37 million and opened in Spring 1999. It used fescue straw to produce particleboard. It was open for only a short time, and was ordered into receivership in September 1999. NEWPRO (Northern Engineered Wood Products) acquired the assets and converted the facility to make particleboards using sawdust and shavings from sawmills in the Peace River area, including major lumber producer Canfor Corp. It employed 50 people but, in January 2006, announced it was closing. The plant is no longer in operation.

2. Current Business Models in Operation

Parkland Industrial Hemp Growers (PIHG) Co-op

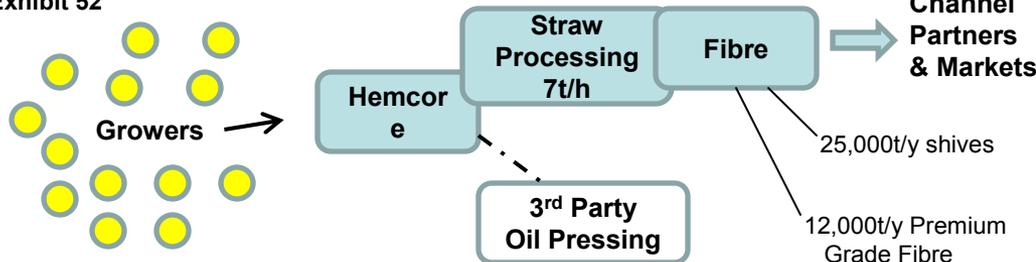
Parkland was formed in 1999 as a means to facilitate the production and processing of industrial hemp. It does not have a processing facility at the present time, although a \$14 million bio-fibre plant was proposed in 2005, and partially funded through a \$3 million federal contribution from Sustainable Development Technology Canada along with provincial and municipal contributions, to be located at Dauphin, MB (source: PIHG business plan announcement and news sources). Parkland came into existence as a growers' co-op following the failure of CGP (see above). The founding members were farmers left stranded with hemp seeds and straw by CGP's failure. PIHG may have revised its processing plant concept since the initial announcement. In 2005, the firm envisaged processing 36,000 tonnes of fibre per year grown on approximately 20,000 to 25,000 acres of farmland. Markets including hemp insulation were envisaged.

Hemcore (UK)

This is a good example of an integrated supply model (www.hemcore.co.uk).

Hemcore has established a well-organized group of hemp growers to supply its processing facilities (Exhibit 52 shows the key elements). It publishes its prices online for the current crop year and provides significant technical support to growers. It has channel partnerships (e.g. with Isonat in France, to produce hemp insulation). Practical processing capacity is believed to be around 7 tonnes per hour, with maximum rated capacity at 10t/h.

Exhibit 52



5. Product Manufacturing: Hemp Insulation & Hemp Board

Exhibit 53

Distribution and Supply Chain Issues:

In-Bound Transportation

Hemp fibre is far less dense than wood fibre. With comparatively low density, hemp stalks coming from the grower cannot be transported great distances .

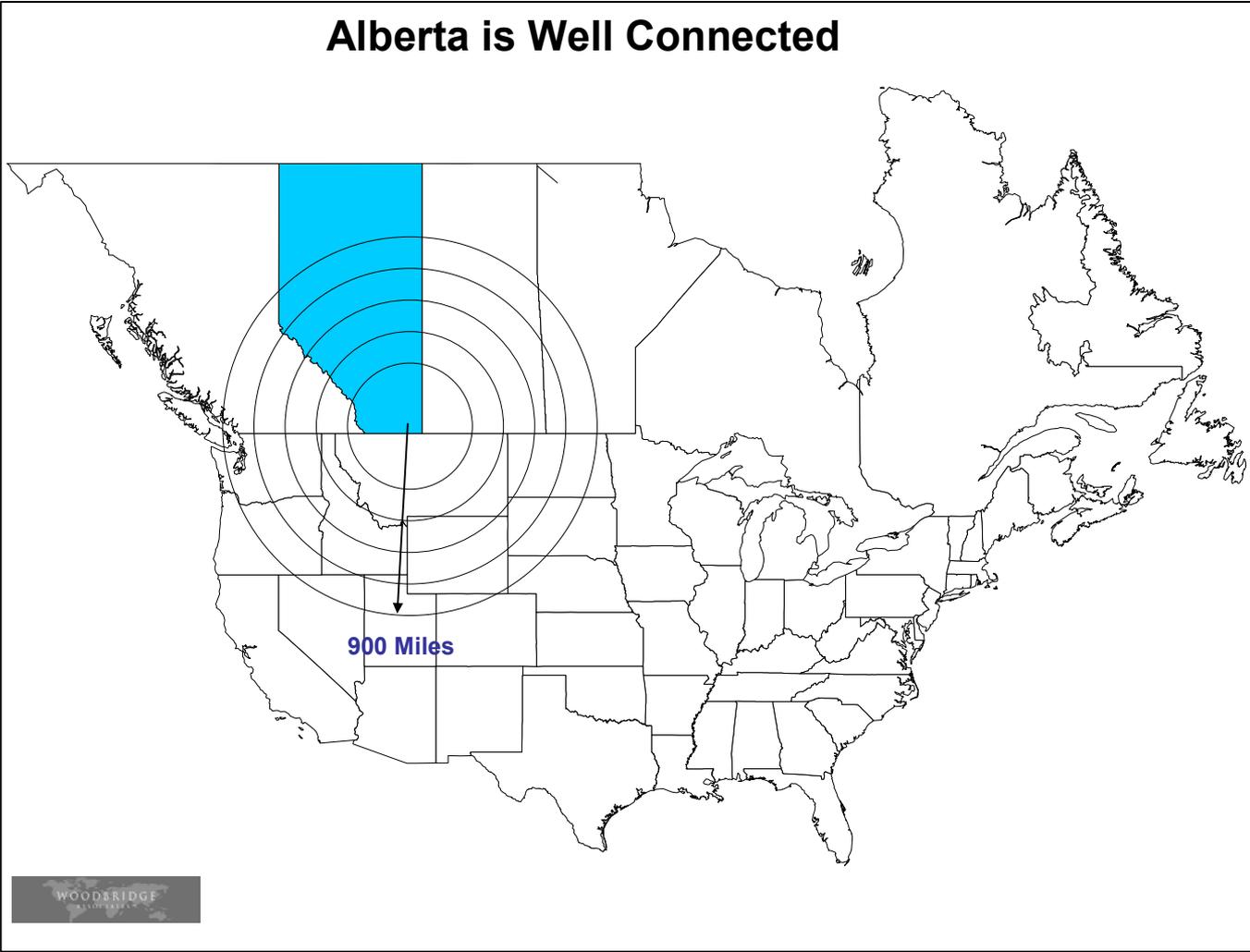
For its growers, in the UK, Hemcore indicates that haulage distances to its processing plant from the grower can be up to a 100 mile radius. Most likely, however, this reflects the more intensive farming systems and land-use in the U.K., especially relating to the location of the firm’s processing facilities. Much longer in-bound transportation distances are more likely to prove to be economic in western Canada.

Out-Bound Transportation

Shipping of intermediate and finished products made from industrial hemp in Alberta could be facilitated by Alberta’s close proximity to several regional markets.

The province has favourable rail and trucking network connections (Exhibit 53) and can boast comparatively low shipping costs to many areas of western Canada, the US West and mountain states. In addition, Alberta is well connected to offshore markets (notably in the Pacific Rim) via Vancouver’s Pacific Gateway.

The importance of channel partners in product distribution already has been emphasized. From a logistics viewpoint, however, processing plants located in Alberta have good support in terms of shipping products, such as hemp insulation, to major markets in these regions.



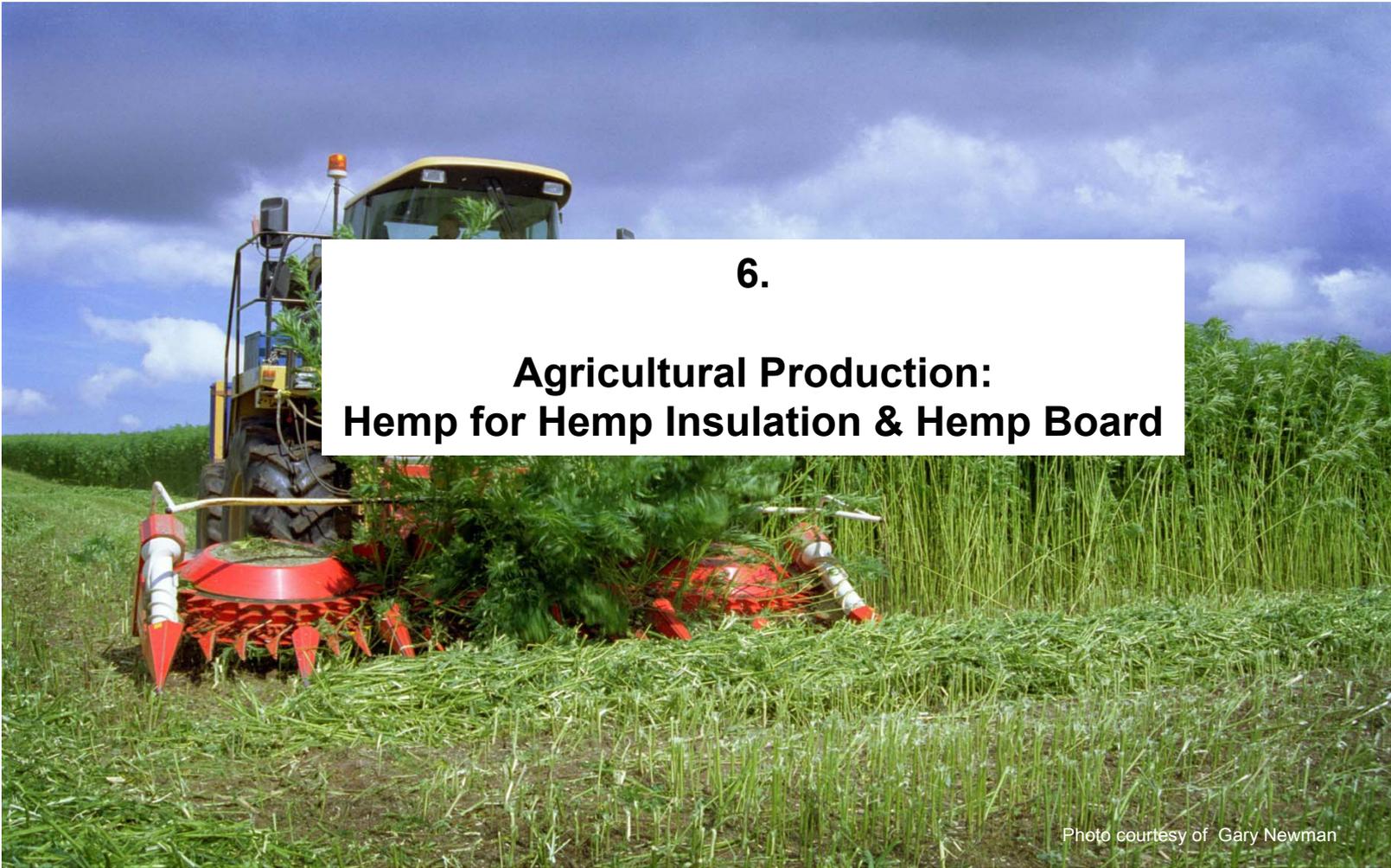


Photo courtesy of Gary Newman

Agricultural Production: Hemp for Hemp Insulation & Hemp Board

Canada's *Industrial Hemp Regulation Program* permits farmers to grow low-TCH cannabis for industrial use, under controlled circumstances.

See www.hc.sc.gc.ca

An 'Infant Industry'

Industrial hemp ('Cannabis sativa', which contains less than 0.3% THC, see below) was grown in Alberta, and in many regions of Canada, for many decades – prior to its being banned in the 1930s. Detailed discussion of the crop's history in Canada, the United States and globally is outside the scope of this report – but plentiful references are available in the public domain. Suffice to say that, because certain varieties of the plant's leaves and flowers contain a hallucinogenic drug known as *delta-9 tetrahydrocannabinol* (TCH), growing of the crop was banned internationally under the United Nations' Single Convention on Narcotic Drugs. In 1998, Canada created Industrial Hemp Regulations (see website above) under the Controlled Drugs and Substances Act. These regulations allow for the controlled production, sale, movement, processing, exporting and importing of industrial hemp and hemp products that conform to conditions imposed by the regulations (source Ontario Agriculture, Food and Rural Affairs www.omafra.gov.on.ca/english/crops/facts/00-067.htm). In terms of its more recent history, the cultivation and harvesting of industrial hemp in Canada began just a decade ago. The first license to grow industrial hemp in Canada was issued in May 1998.

As a result of its very short commercial history, it is easy for enthusiasts and antagonists, respectively, to (a) over-emphasize the crop's potential and (b) dismiss it as a marginal and insignificant crop. This report argues neither case. The purpose of the report is to assess, from a commercial and market viewpoint, if there is a prima facie business case for industrial hemp growing and processing in Alberta. This is evaluated in terms of manufacturing two specific industrial hemp products; namely, hemp insulation and hemp boards. Other industrial hemp products (such as hemp oil, hemp grain and pharmaceuticals) are not evaluated in any detail.

Notwithstanding our focus on two specific products, some widely-held viewpoints on all industrial hemp products are relevant. In 2000, for example, the USDA's Economic Research Service ('ERS') concluded that:

"U.S. markets for hemp fibre ...and seed...are, and likely will remain, small, thin markets. Uncertainty about long-run demand for hemp products and the potential for oversupply discounts the prospects for hemp as an economically viable alternative crop for American farmers."
Source: USDA 2000 in Rawson (March 2007)

This negative, but comparatively recent, forecast stands in contrast to subsequent analyses. Rawson notes that interest in the crop has expanded since the ERS report.

"It often takes 10 to 15 years for the industry associated with a new agricultural crop to mature. North American production is only [recent] in CanadaViewed from this perspective, the hemp industry in North America is still very much in its infancy ...and is likely to continue experiencing the risks inherent in a small niche market for some time."
Source: Small and Marcus in Rawson (ibid)

"Hemp's remarkable advantages are hard to beat: it thrives without herbicides, it reinvigorates the soil, it requires less water than cotton, it matures in three to four months, and it can yield four times as much paper per acre as trees. Hemp can be used to create building materials that are twice as strong as wood and concrete, textile fibre that is stronger than cotton, better oil and paint than petroleum, clean burning diesel fuel, and biodegradable plastics. In addition, it can produce more digestible protein per acre than any other food source"
Source: Agriculture Canada (Update report 2007) in Rawson (ibid).

6. Agricultural Production: Hemp for Hemp Insulation & Hemp Board

Parts of the Hemp Plant

Virtually every part of the hemp plant can be used. The whole plant can be used for fuel; the seeds produce oil and other products, while the stalk produces the **hurds** and **bast fibres** (Exhibit 54) of central interest to this report.

Exhibit 54

Hurds

These are the non fibrous or woody inner layer of the stem. They are used for special blends of paper, rayon, fuel, cellophane, food additives, animal bedding and building materials.

Bast Fibres

These are from the phloem layer, and comprise coarse, medium and fine fibres used in building materials, carpeting, insulation, clothing and paper, such as cigarette papers in some regions of the world (e.g. Turkey).

The following products are not the focus of this report. But they may represent commercial products of interest to the grower and processor.

Hemp Grain

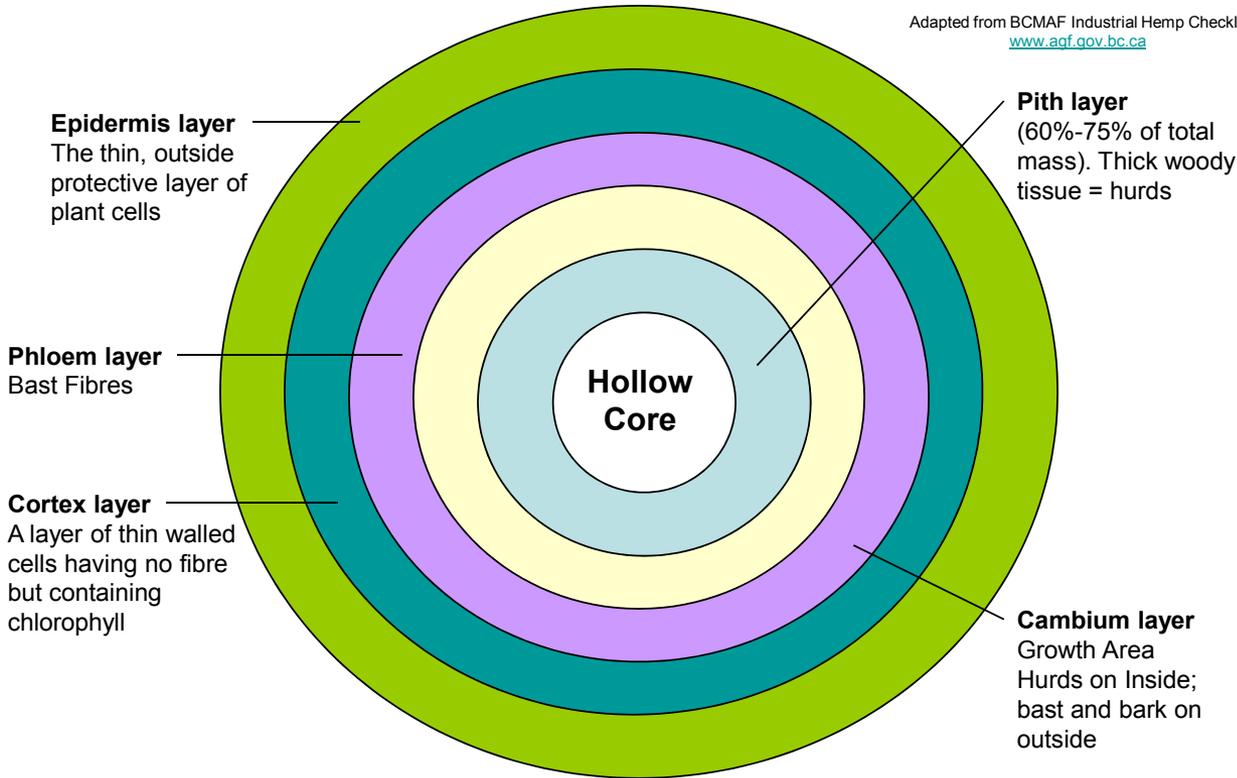
This is a source of food oil and meal and has many applications for human and animal food products. Hemp oil contains a unique mixture of omega-6 and omega-3 fatty acids, as well as gamma linolenic acid (GLA), which is an acid involved in the synthesis of prostaglandins in the body.

Hemp Oil

The oil is used in cosmetic creams and food products. The main drawbacks at present are reported to be oil extraction technology and stability of the oil. (source: Ontario Agriculture, Food and Rural Affairs *ibid*)

Hemp Stem – Cross Section

Adapted from BCMAF Industrial Hemp Checklist www.agf.gov.bc.ca



Colour-Enhanced to Show Various Parts of the Stem (Not to Scale)



6. Agricultural Production: Hemp for Hemp Insulation & Hemp Board



Industrial Hemp Harvesting In Europe

Photo courtesy of Gary Newman

Exhibit 55

Canada's global competitive edge in industrial hemp production could be derived from (#1) its large economies of scale and (#2) close proximity to the potentially huge U.S. market.

6. Agricultural Production: Hemp for Hemp Insulation & Hemp Board

Potential Economies of Scale in Alberta

One of the arguments frequently advanced to support the development potential for a large scale, low unit cost industrial hemp growing sector in Alberta is that large sized farms exist compared with regions such as Europe – where most of the industrial hemp used in the products noted earlier currently is grown. The implication is that Alberta, using economies of scale and achieving high productivity levels, can achieve low unit costs of production. Different farms types in Canada have to be differentiated because livestock (e.g. poultry farms) areas are very different from dairy and arable farms sizes. Overall, within Canada, Saskatchewan has the largest farms. Moreover, throughout Canada, the arable farmland base has remained about constant, while the number of farms has declined. The result is a rise in average farm size.

Can Alberta Farms Support a World Scale Industrial Hemp Industry?

The Parkland (PIHG) business plan in 2005 envisaged that an area of around 10,000 hectares (approximately 25,000 ha) would be necessary initially to provide the hemp straw required to support the world scale processing unit planned for Dauphin in Manitoba.

Assuming this represents the appropriate economy of scale today, how many farms in Alberta (and in which regions of the province) would be capable theoretically of supporting this requirement? Exhibit 56 provides data from the 2001 Census of Agriculture for Alberta. It shows a total of over 53 thousand farms at that time, with the majority of these located in the central and south regions of the province (Exhibit 57). Overall, 6% of farms in Alberta (comprising all farm types) are in the 1,165 to 1,425 hectare and larger size category. This is approximately 3,300 farms. Many smaller and medium scale farmers also may be interested in becoming industrial hemp growers. Assuming that no more than 20% of any farmer's land area is dedicated to this crop at any one time, and assuming an 80 hectare minimum commitment (see SOTA growing operation in Section >) to industrial hemp, there are over 12,000 farms throughout Alberta that could meet this requirement.

The 80 hectare minimum land area commitment assumed for Alberta compares with a minimum of 10 hectares indicated for the U.K. on the Hemcore website (www.hemcore.co.uk) It appears that a large number of farms, well distributed throughout Alberta, could support a global scale industrial hemp processing facility in their area.

Exhibit 57

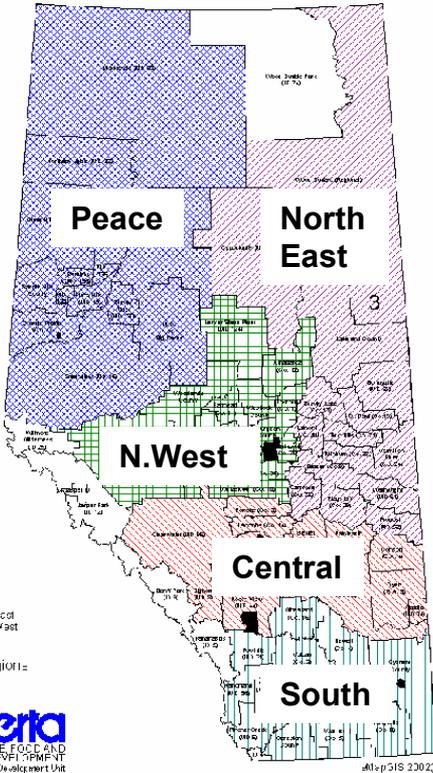


Exhibit 56

Farm Size in Alberta 2001 Census (Statistics Canada)

Region	Total # of Farms	< 100 ha	100-650 ha	~650-1165ha	~1165 -1425 ha and over
South	10,072	33%	44%	12%	11%
Central	13,561	38%	46%	9%	7%
North East	10,466	28%	55%	11%	6%
North West	12,621	44%	51%	4%	1%
Peace	6,932	24%	58%	12%	6%
Total (Wtd Av.)	53,652	35%	50%	9%	6%



Statistics and Data Development Unit

6. Agricultural Production: Hemp for Hemp Insulation & Hemp Board

Growth and Yield

This is a topic largely outside the scope of the business case analysis. Numerous studies and reports can be found on provincial government websites, as noted in the citations. It is useful, however, to review the subject very briefly from the point of view of discussing the 'opportunity cost' of land dedicated to growing industrial hemp compared with alternative crops and trees.

Hemp (Exhibit 58)

As noted earlier, yield of fibre depends on the variety, stalk yield per hectare and the fibre yield content of the stalk. This varies by region, and within each region. Depending on the cultivar (i.e. varieties such as Anka, Fasamo, Felina) air dry stem yields from 2.6 to 14.0 tonnes of dry retted stalks per hectare (1 tonne to 5.5 tonnes per acre) have been reported in Ontario (source: OMAFRA 2009). In BC, yields of 4-12 tonnes per hectare have been reported, with usable bast fibre representing 35% of the total (or 1.4 to 4.2 tonnes per hectare). Source: BCMAF

Flax

Flax is widely grown in Alberta and western Canada. The yield of straw is 1.5-2.0 tonnes per hectare. The seed commands a favourable price form oil. Residual straw typically is baled and sold.

Hybrid Poplar

Several references have been made throughout this report to the competition for market share between fibres derived from trees (wood cellulose) and hemp, and to potentially emerging shortages of economically accessible sawlogs and pulp logs.

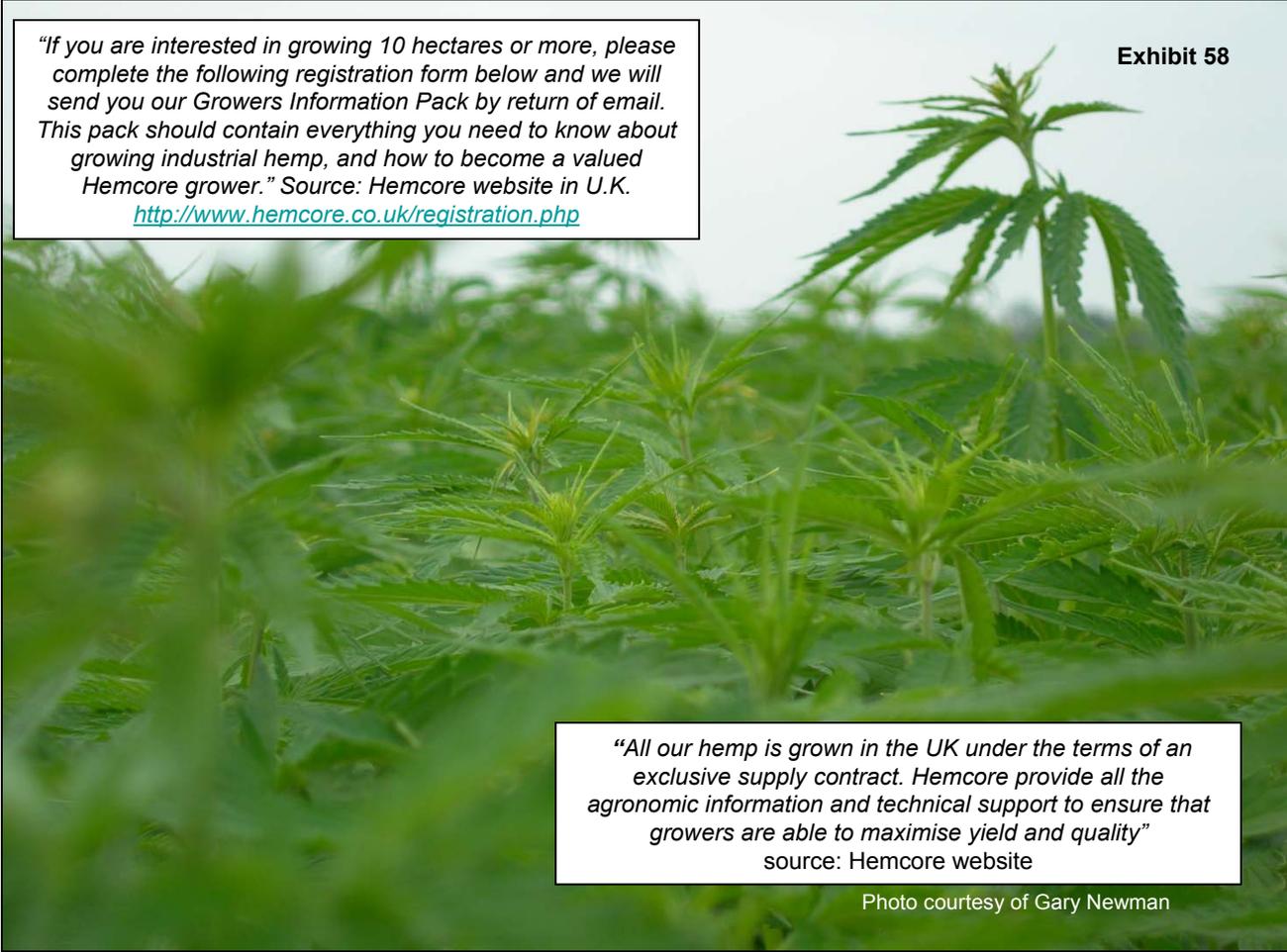
It is interesting to note, in this context, that in western Canada cultivated hybrid poplar (grown in the Peace River region) will produce 1.5 tonnes per hectare per year of chip quality fibre while, in the south of the province, these yields can rise to 9 tonnes per hectare per year.

"If you are interested in growing 10 hectares or more, please complete the following registration form below and we will send you our Growers Information Pack by return of email. This pack should contain everything you need to know about growing industrial hemp, and how to become a valued Hemcore grower." Source: Hemcore website in U.K. <http://www.hemcore.co.uk/registration.php>

"All our hemp is grown in the UK under the terms of an exclusive supply contract. Hemcore provide all the agronomic information and technical support to ensure that growers are able to maximise yield and quality" source: Hemcore website

Photo courtesy of Gary Newman

Exhibit 58



6. Agricultural Production: Hemp for Hemp Insulation & Hemp Board

Industrial Hemp Statistics

Due to the need for licensing, statistics for Canada’s area licensed and under industrial hemp cultivation are more readily available than the yields of hemp products. Exhibit 59 shows the Canada’s total production –in terms of hectares harvested. This is roughly equivalent to the total number of hectares licensed annually. It is clear from the data that a significant surge in grower interest occurred soon after the new regulations permitting industrial hemp cultivation came into effect. The number of hectares licensed and in production dropped sharply after the initial surge in interest –but recovered sharply in 2006 (Exhibit 59).

Exhibit 59

Several observations are appropriate.

It is clear that growers’ expectations were high around the time that the first license was issued in 1998. In 1999, around 14,200 hectares across Canada were licensed for industrial hemp cultivation. Much of this volume was in Manitoba and was associated with an ill-fated attempt at rapid commercialization (see discussion later regarding CGP).

Partly because of the CGP failure, but also due to results falling well below (the very high) expectations built up around the country, the national area in production quickly declined to just over one thousand hectares in 2001. It remained that way for several years.

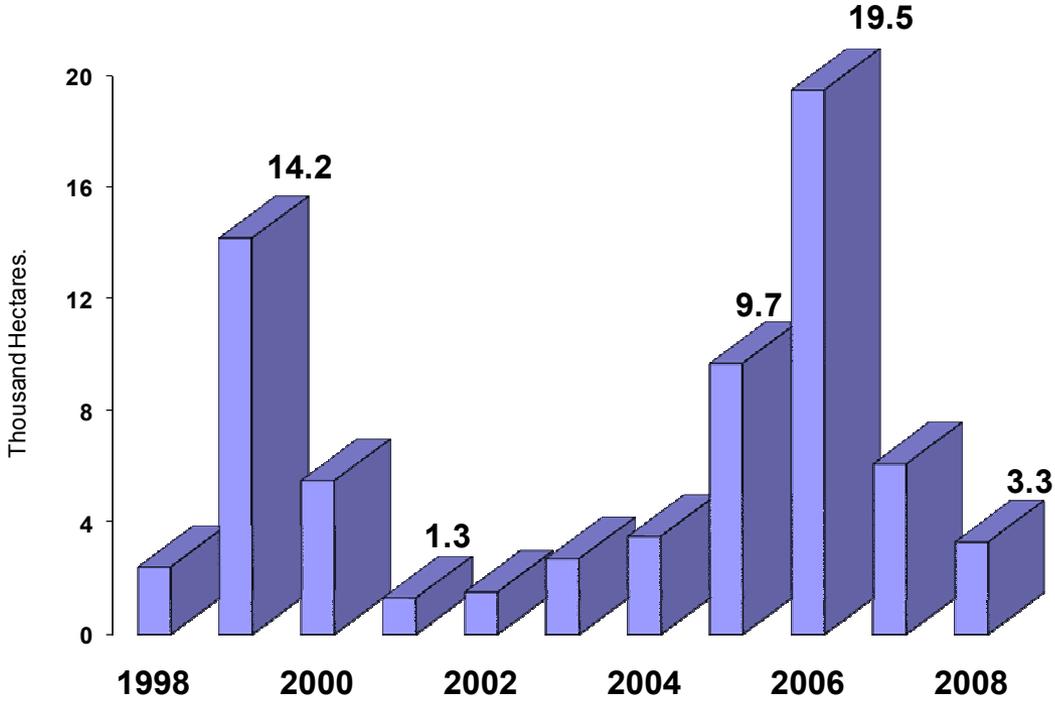
A surge in production occurred in again 2005 –and peaked suddenly in 2006 when a record 19,500 hectares of industrial hemp were under cultivation. As noted in the previous section, Canada’s exports to the United States surged in 2006 and 2007 – represented mainly by hemp fibre exports. But there was also a surge in hemp seed imports into Canada around this time.

Broadly Based Response After 1998, Before Collapsing

Overall, the initial response across Canada to the lifting of the ban on industrial hemp cultivation was that growers in all provinces committed acreage to the crop. Thus, all provinces (but Ontario and the western provinces in particular) increased their cultivation areas in 1999.

In Ontario, however, after the initial surge, growers’ interest in producing industrial hemp collapsed. As Exhibit 60 (see next page) shows, the area under hemp dropped from 1,163 hectares in 1998 to just 142 hectares by the year 2002.

Industrial Hemp Production in Canada Thousand Hectares



Data source: Health Canada

6. Agricultural Production: Hemp for Hemp Insulation & Hemp Board

Western Canada Now Dominates Canadian Production

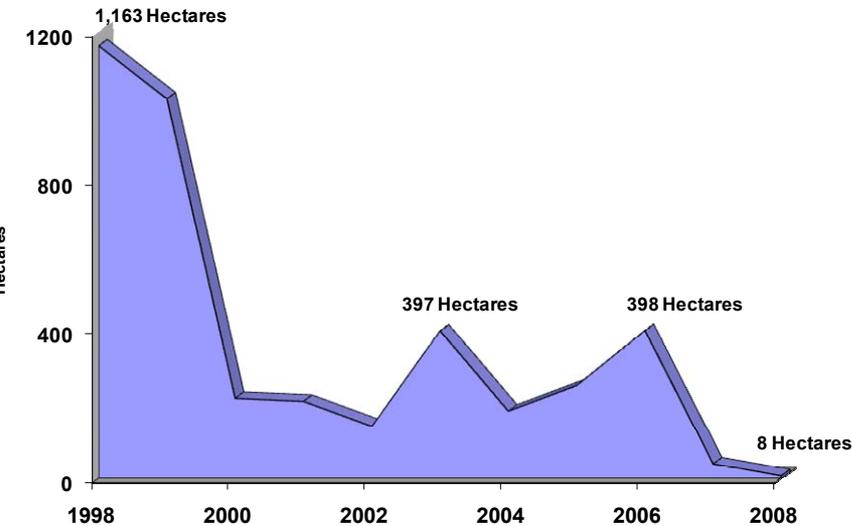
With the collapse of growers' interest in producing industrial hemp in eastern Canada, western Canada now accounts for almost all of Canada's output. The series of events is illustrated in Exhibit 61.

From a supply-share of 41% of Canada's total in 1998, western Canada's share of total supply quickly increased to 91% as production everywhere - but particularly in Manitoba and Saskatchewan sky-rocketed. The West's supply-share has been maintained since then. Manitoba dominates supply with 51% of Canada's total production (in terms of hectares) over the period 1998-2008. Saskatchewan has accounted for another 30% in total over the same period. Alberta accounts for 10% - making the Canadian Prairies, in aggregate, the location of 91% of Canada's industrial hemp production over the period 1998 to 2008.

BC accounted for only 2% of the total, while Ontario accounted for 6% and all other provinces combined accounted for the remainder (percentages are rounded).

Exhibit 60

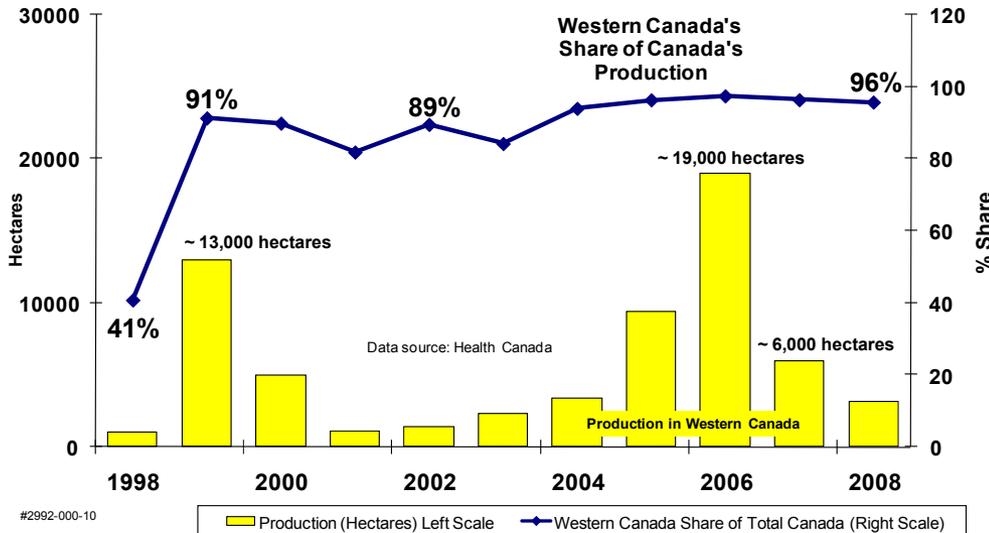
Industrial Hemp Production: Ontario



Data source: Health Canada

Exhibit 61

Industrial Hemp Production: Western Canada (Mostly Manitoba & Saskatchewan) Dominate



Data source: Health Canada

#2992-000-10

Production (Hectares) Left Scale Western Canada Share of Total Canada (Right Scale)

6. Agricultural Production: Hemp Insulation & Hemp Board

Recent Surge, then Decline in Alberta's Production

The level of interest by Alberta growers in industrial hemp production began modestly. Unlike most other provinces of Canada, the initial surge in interest was comparatively mild. Production jumped to 754 hectares by 1999, but settled back until 2003. There was a surge in production starting in 2004 (Exhibit 62) and lasting through 2007 – when Alberta accounted for a rising part of Canada’s at-that-time rapidly growing level of hemp fibre exports to the United States.

Exhibit 62

By 2006, Alberta had a record 2,103 hectares of land in hemp production. This declined sharply in 2007 and again in 2008.

Investors' and Processors' Perspective

Looking at this set of production charts, most investors would conclude that industrial hemp production in Canada is highly sporadic. Even though Canada’s Prairie provinces have maintained a significant area under industrial hemp production, the area and total output of the crop have varied sharply from year to year. Events such as the CGP venture are only part of this picture.

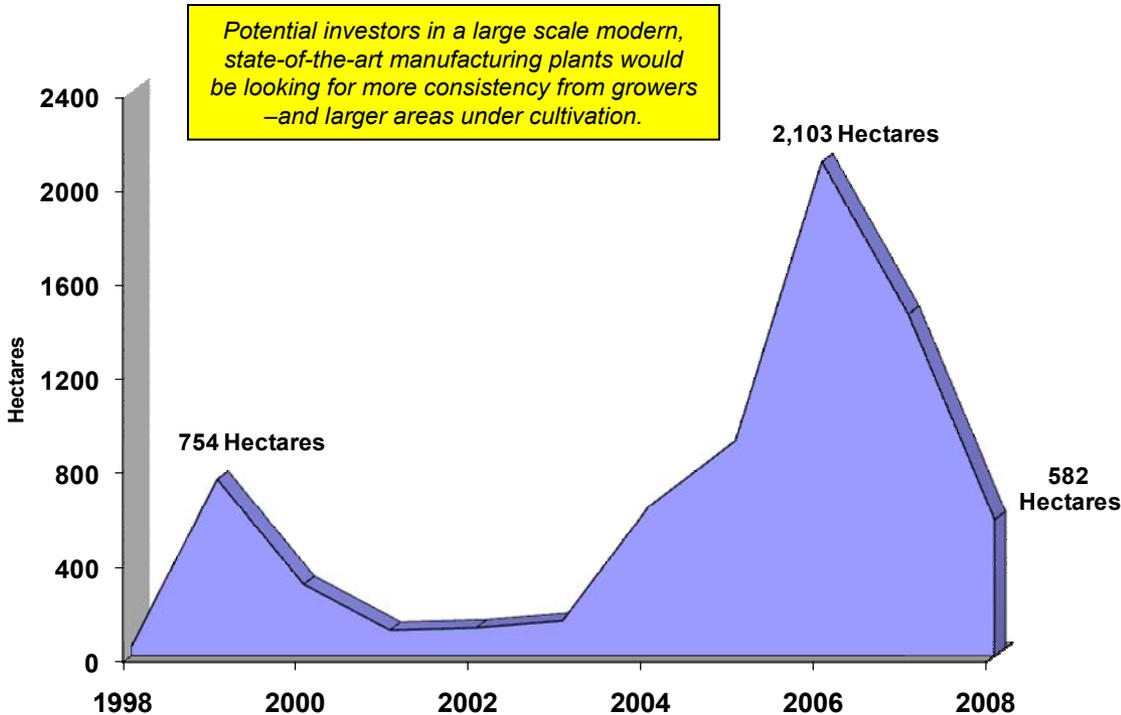
As noted in the previous section, processors’ need a consistent area in production – not least because, only in this way, can the processing plant and the growers work together to improve yields, select the best cultivars for specific products and work on logistics of achieving crop quality. In the CGP case in Manitoba, growers responded well – and it was a processor’s failure at fault.

Although several important growers within the Canadian Prairie provinces have made a long term commitment to industrial hemp production, many others haven’t. It has been difficult to develop a sustainable ‘industrial hemp culture’ in several regions.

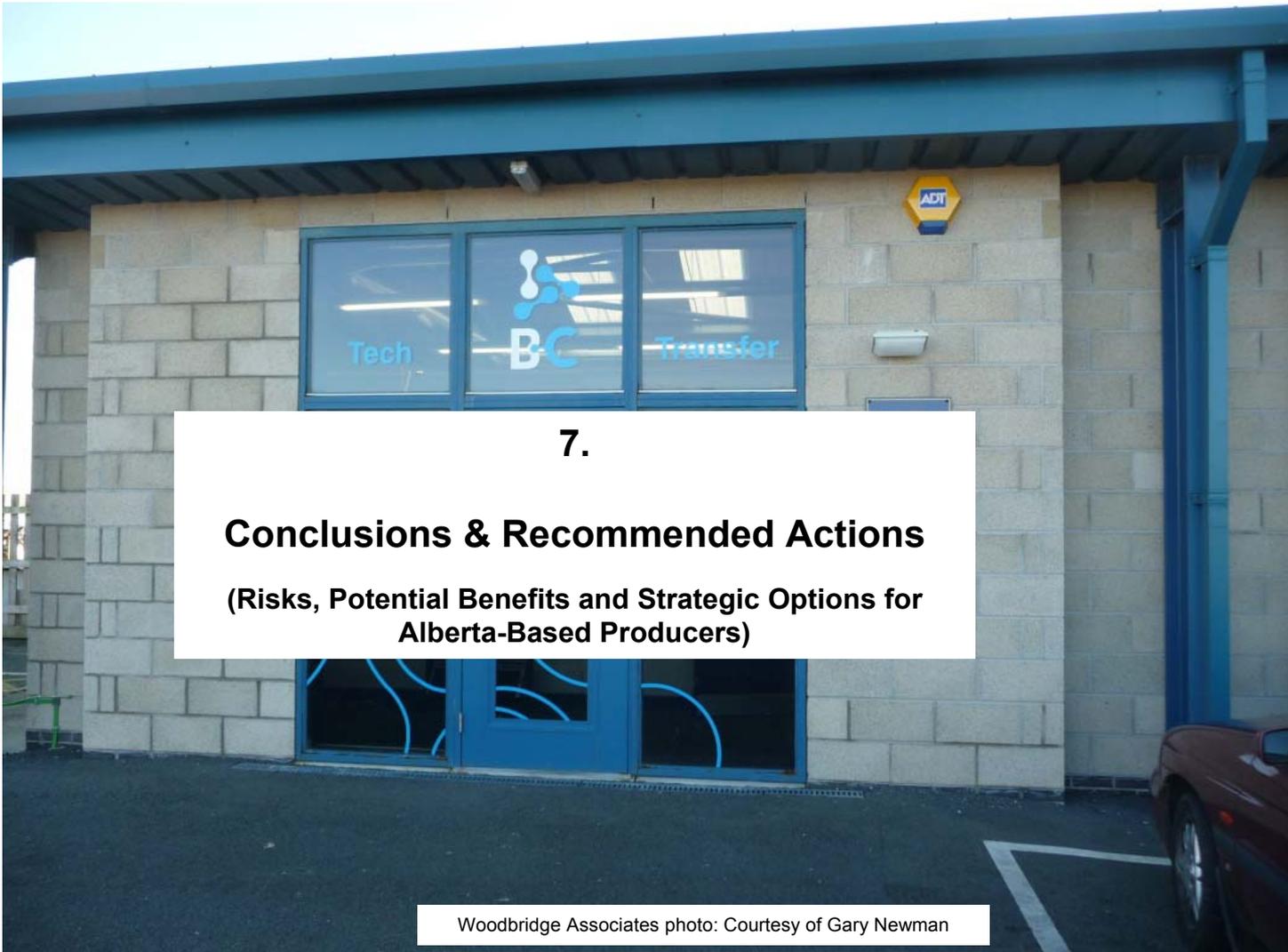
As noted, much of the sporadic production of the industrial hemp growing industry in Canada can be attributed to lack of consistency on the processing and product manufacturing side. Markets for industrial hemp products also have been sporadic in nature. Moreover, prices paid to growers (and sales prices available to processors) have fluctuated over this period.

Notwithstanding this, potential investors in a large scale modern, state-of-the-art new plant presumably would be looking for consistency from growers – and larger areas under cultivation.

Industrial Hemp Production: Alberta



Data source: Health Canada



7.

Conclusions & Recommended Actions

(Risks, Potential Benefits and Strategic Options for Alberta-Based Producers)

Woodbridge Associates photo: Courtesy of Gary Newman

7. Conclusions & Recommended Actions

Report Focus

The purpose of this report is to evaluate the prima facie business case for two industrial hemp products – hemp insulation and hemp boards – for potential large scale production in Alberta. The two case evaluations are presented in parallel because they depend on a common resource (industrial hemp) that potentially could be grown by farmers in Alberta working as a co-operative or in collaboration with a primary processor of the hemp fibre. This approach is essential because there is no established commodity, or specialty market, for industrial hemp that can be compared with the well developed commodity markets for other crops (such as wheat and canola) grown in Canada. Farmers who may be tempted to simply 'launch-out' on their own and grow industrial hemp (under license) will meet significant commercial obstacles to success.

The industrial hemp industry globally is in its infancy, and has only a decade of experience in its modern setting. In order to achieve a successful business model, Alberta growers and processors would have to agree to a common vision of the industrial hemp cultivars (varieties or strains) to be grown (along with many other aspects of growing). In addition, they would have to reach a common vision of the products to be manufactured. There are several crop-priority options. In a global competitive and processing sense, they are not readily interchangeable – and several are mutually exclusive. For instance, for highest productivity and peak effectiveness as a business sector, growers have to optimize for hemp oil seeds or high grade hemp fibre –but, ultimately, not for both.

In this context, from our market-driven evaluations, there appear to be no obvious 'prima facie' business cases, and certainly no "slam-dunk" arguments, in favour of large scale industrial hemp growing in Alberta. There are several sets of reasons for this conclusion.

There is no established commodity or specialty market for industrial hemp that can be compared with the well developed commodity markets and demand for other crops (such as wheat and canola) grown in Canada.

Market Competition and Entry Price Points

- Both of the potential industrial hemp products being considered for Alberta would have to enter well-established, highly competitive markets. Both products would be price-takers, and very little (if any) price premium should be expected for these products in the marketplace – if they are planned as long term financially sustainable mainstream commercial products rather than niche, 'fad' items that will appeal only to a small segment of the market.
- In relation to existing products that dominate North American thermal insulation markets, hemp insulation has several impressive performance characteristics and potential unique selling points ('USPs'). Even so, we strongly recommend that it should not be commercialized as a 'niche market' product with the expectation that a price premium will be achieved. We believe that it should be branded, and vigorously marketed as a safe, benign, and highly desirable 'green building product' in direct competition with existing products that are vulnerable to declining levels of consumer-acceptance – notably products such as fibreglass insulation and (to a lesser extent) foamed plastic insulation.
- To be able to meet the market entry requirements, and overcome significant obstacles to building trade and consumer acceptance, hemp insulation – in our view – will have to be priced competitively with these existing products – and in particular with glass fibre insulation batts. This is the most readily suitable form for widespread distribution and application of industrial hemp insulation. On this basis, with its superior quality and performance attributes –and as well marketed and technically supported branded 'green building' product – we believe that industrial hemp insulation batts could quickly gain market share from fibreglass batts in residential, commercial and industrial markets. LEED acceptance should be sought, and leveraged as a sales tool. This will require large scale manufacturing operations.
- We are far less optimistic about the business case for low and medium density hemp boards, for reasons explained in previous sections. With declining, and increasingly more expensive, supplies of wood fibre expected to emerge in North America over the next 5-10 years, the business case for these boards could be re-visited in the future. Their most likely role could be, not as finished boards, but in the form of long, strong hemp fibres used as a reinforcing fibre for existing low and medium density fibreboards. We are optimistic, however, about the market potential for high density hemp fibreboards in automotive applications. This is an emerging market with tremendous potential, but needs to be approached carefully. It should be thought of as one of several high quality hemp fibre products that could be manufactured by processors in Alberta. The 'Eco-Technilin' business model in France appears to indicate the correct commercial approach for this product.

7. Conclusions & Recommended Actions

Strategic Outlook for Industrial Hemp Industry Development in Alberta

In our scenario planning, we have developed four possible development tracks for industrial hemp cultivation and commercialization in Alberta. These are as follows, and are as illustrated conceptually in Exhibit 63. It should be noted that the values in the Exhibit are completely hypothetical. They are intended to facilitate policy level discussions within Alberta and should not be used as a guide to commercial investment decisions by growers, processors or capital providers.

Possible Scenarios

#1 'Trapped Opportunity Scenario'

In our view, this is the present situation in Alberta. The industry is showing no signs of growth. The market opportunities identified previously and outline in this report have not culminated in a major processing facility within the province. Industrial hemp is grown as a crop, but production is sporadic and inconsistent. Growers rely opportunistically on export market opportunities in the United States. The market opportunity for hemp has been eclipsed by other products.

#2 'Cottage Industry Scenario'

Regions where industrial hemp has become established as a 'cottage industry' typically have some (although limited) processing capacity available locally, or they have established a modest, but steady growth, in exports of hemp seeds and stalks (straw). With rising U.S. and Canadian demand, this is a probable development scenario for Alberta farmers (similar to the existing situation in Manitoba). But this scenario assumes that a significant scale processing facility is not built locally. Growers are dependent on exports of seeds & stalks to other regions.

#3 'Breakout Scenario'

This assumes that a significant scale processing facility (along the lines outlined in this report) is built in Alberta – thus launching the industry as a potentially sustainable growth sector and expanding its domestic and export markets.

#4 'Rapid Industrialization Scenario'

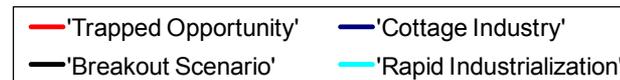
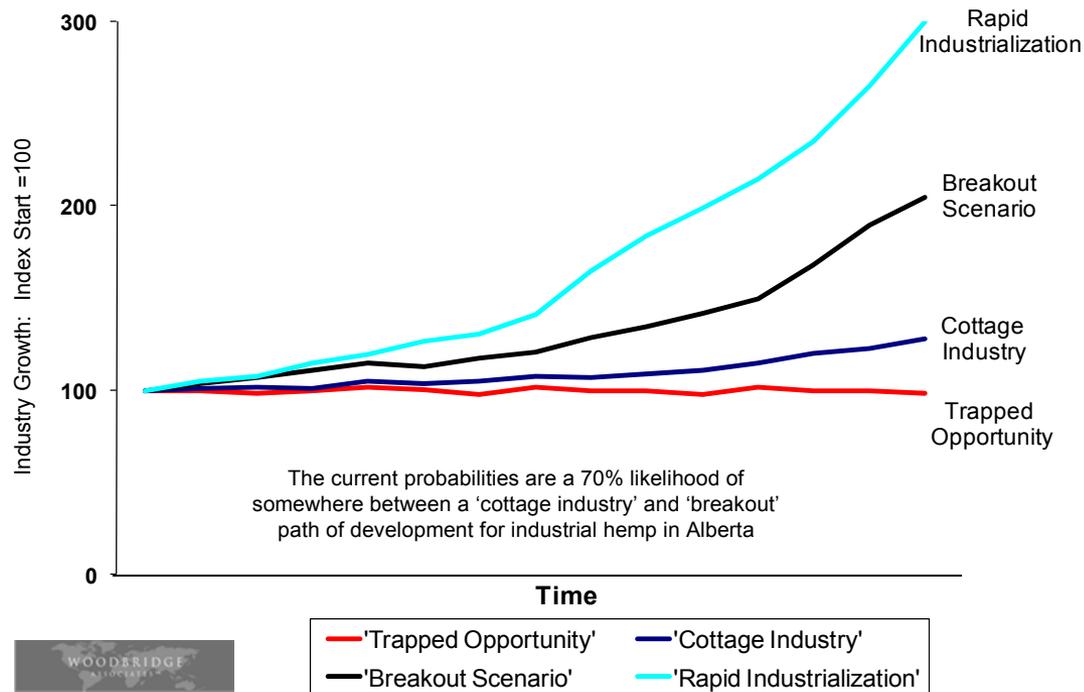
A significant investment, and/or long term contractual commitment, by a major 'outside player' (such as an insulation industry or automotive sector channel partner) would be necessary to kick-start rapid industrialization. This would provide the impetus for local investors.

In our view, the current probabilities are a 70% likelihood of somewhere between a 'cottage industry' and 'breakout' path of development.

Exhibit 63

Industrial Hemp: Alberta Industry Development Scenarios

Conceptual: For Illustration Purposes Only



7. Conclusions & Recommended Actions

Economic Development Payback for Alberta

It is not possible, within the scope of this report, to determine the magnitude of the risks and rewards involved in each of the four development scenarios outlined on the previous page. This is, however, an assessment which should be carried out. In Section >, for example, we identified the market potential for four state-of-the-art industrial hemp insulation plants that could be built in North America over the next five years. The investment dollars are significant. Our report also has identified the potential for several hemp processing plants, and the opportunity for numerous farmers in Alberta to grow industrial hemp profitably – if these processing and further manufacturing facilities are put in place. Several other product opportunities have been identified.

From a public policy perspective in Alberta, the 'green building product' nature of the two product groups evaluated in this report also provides an opportunity to help establish the province as a pro-active champion of eliminating GHG (greenhouse gas) emissions from the supply chain, within North America, that produces GHGs in the manufacturing of existing products (e.g. fibreglass insulation, plastics and fibreglass used in the automotive sector). With the potential in North America for carbon pricing –and the possible introduction of a cap-and-trade system, Alberta's investments in these 'green building products' could significantly help offset some of the GHGs associated with its Oil Sands development. In cap-and-trade carbon pricing systems, the industrial hemp development opportunity within Alberta could provide a substantial return on initial economic development efforts. Even without factoring-in these 'soft' investment issues, we believe that the commercial payback from industrial hemp development could be sizeable.

In Manitoba, the industrial hemp facility proposed by PIHG in 2005 still has not been built – but it attracted over \$6 million in government financial support, in anticipation of a significant payback to farmers, processors and various employment and income spinoffs. In the meantime, PIHG has been developing the hemp-growing side of the business and would be a potential resource of knowledge for growers in Alberta and elsewhere. The PIHG 'Co-op organizational model' may be one that could be considered in Alberta.

Getting Started in Alberta

What are the constraints to development of an industrial hemp growing farmers group, and attraction into Alberta of a similar type of investment to PIHG? In the remainder of this section we list and evaluate the factors which could be preventing this opportunity from being pursued in Alberta. There are several headings.

Development Constraints in Alberta

- #1 Currently Poor and High-Risk World Macro-Economic Conditions
- #2 Lack of Knowledge, and/or Misunderstandings and Suspicions, about the Industrial Hemp Investment Opportunity
- #3 Lack of Sufficient Information to Carry Out a 'Bankable Grade' Business Case
- #4 Absence of Support from Channel Partners and Large Scale Product End-Users
- #5 Lack of Technical Knowledge within Alberta about Industrial Hemp Processing, and Product Manufacturing

#1 Currently Poor and High-Risk World Macro-Economic Conditions

It is beyond the scope of this report to offer any predictions about if, or when, the current very poor and (for new investors) high-risk global macro-economic conditions will improve to the level where the opportunities outlined in this report could become attractive. In any case, such predictions may not be relevant. Many companies operating in the markets targeted by the two industrial hemp product groups (notably in the automotive and thermal insulation sectors) recently have been, and currently may still be, very active in seeking viable 'green product' alternatives to the materials and products they are using today. In addition, with respect to the opportunity for hemp long fibres to provide reinforcing fibres in wood products, existing producers are aware of the longer term need to seek viable, green alternatives – such as hemp fibres.

Recommendation #1: The Government of Alberta (GoA) should not try to 'second guess' investors' intentions. Instead, the business case for investing in industrial hemp in Alberta should be (a) further developed [see #3 above] to a bankable-grade investment case and (b) vigorously pursued with prospective investors.

7. Conclusions & Recommended Actions

Economic Development Payback for Alberta (continued)

#2 Lack of Knowledge, and/or Misunderstandings and Suspicions, about the Industrial Hemp Investment Opportunity

Among hemp growers in western Canada, and probably elsewhere too, the ill-fated CGP potential processing venture in Manitoba in 1999-2000 (and its aftermath) most likely has left some Manitoba growers for the venture bitter about the treatment they received from CGP – and most likely has left others (including potential growers in Alberta) deeply suspicious of grandiose promises from potential processors.

In addition to this, from a reading of the existing literature, it appears that although there are extensive publications related to growing industrial hemp, there are few places to which a prospective grower can go for detailed commercial advice and business case development (PIHG may be an exception, for farmers in Manitoba). Trade associations and industry suppliers such as Canadian Seed Growers, Manitoba Industrial Hemp Association and others are able to provide part of the picture, notably agronomics information. Provincial ministries of agriculture in Canada provide production cost estimates or guidelines, and Health Canada provides information about licenses and regulations. Overall, however, business case information (based, for example, on analyses and evaluations of market opportunities as in the case of this report) is deficient.

Faced with much better quality information about other crops and alternative crops, most farmers are more likely to downgrade or dismiss the opportunity to grow industrial hemp, rather than spend their limited free time researching the crop's potential. Regrettably, this lack of knowledge also leaves them vulnerable to, and unable to properly evaluate, CGP-type proposals.

Recommendation #2: The GoA, through ARD and others, should develop a strategic plan for industrial hemp development in Alberta. It would be simple but, in our view, a potential error simply to make a report such as this available to potential growers. Much more homework, along with supporting research from ARC (see below) and others, needs to be carried out before a public launch of the industrial hemp opportunity is launched among farmers in Alberta. With a false-launch, growers' expectations can again be built up too rapidly. More particularly, a better approach in our view would be to develop a long term plan (for internal use within Alberta) along with a series of economic development initiatives aimed at attracting potential channel partners, end users and capital providers. Once resources have been identified, the plan can be rolled out and follow-up steps implemented as appropriate.

The strategic plan also should identify ways in which collaboration between existing producing regions and firms and institutions (e.g. in Europe) can be utilized to help develop large scale industrial hemp enterprises, and commercial processing units, in Alberta. A strong R&D and technical research support approach is recommended. In terms of timing, these initiatives should be undertaken immediately. They are an essential precursor to attracting future investment.

#3 Lack of Sufficient Information to Carry Out a 'Bankable Grade' Business Case

This report provides a useful starting point to the more detailed levels of analysis and due diligence assessments needs to evaluate the 'bankability' of the two product group opportunities presented. Investment grade analyses will have to undertaken by potential investors in processing facilities. These quickly become proprietary to the potential investor, but the GoA can assist the process in several ways. One of the key requirements is to establish an easy-to-access portal, or point of contact, for potential investors with regard to gaining quick access to a wide range of information types needed to support a bankable assessment. A key contact person should be identified within the GoA. This will be important to ensure continuity of follow-up and to ensure that effective links are made with supporting institutions, such as potential pilot plant trails at Alberta Research Council. In addition, the key contact person should have adequate resources to bring together supporting players provincially and related information, and be able to coordinate and distribute these resources among interested parties.

Recommendation #3. The GoA should consider appointing a key contact person who would "champion" the industrial hemp opportunity within, and outside, Alberta.

7. Conclusions & Recommended Actions

Economic Development Payback for Alberta (continued)

#4 Absence of Support from Channel Partners and Large Scale Product End-Users

The difference between the 'Breakout Scenario' and the 'Rapid Industrialization Scenario' identified earlier is the extent to which key players from end-use (or distributing) sectors can be convinced to become engaged in a purposeful dialogue about the opportunities. Their focus will not be on Alberta and its interests, but on finding solutions for their businesses. Thus, it is vital to approach the industrial hemp opportunity from their perspective. The first task will be to identify who they are, and gain a full understanding of how Alberta may be able to (i) provide and (ii) adequately communicate this potential to them. In addition, a thorough understanding of likely levels of competition from other products will be required –as part of presenting a business pitch.

Recommendation #4: The GoA should give some thought to a marketing, promotions and communications strategy in support of these opportunities. Potential initiatives that could be undertaken include (a) identifying a 'long-list' of targeted firms for contact (b) hosting an investor-focused conference within Alberta on the market opportunities identified and (c) providing a synopsis of this report to pre-qualified interested parties, with more detailed follow-up as merited.

#5 Lack of Technical Knowledge within Alberta about Industrial Hemp Processing, and Product Manufacturing

It is our understanding that key R&D institutions, such as ARC, have a well developed understanding of technical aspects of industrial fibre processing – including hemp. In addition, knowledge of the global picture and business case basics also probably resides within ARC's senior research staff. Key personnel apparently have traveled to Europe and are familiar with manufacturing processes at commercial producers there. There is, however, a strong case to be made for pilot level trials to be carried out within Alberta – specific to the two industrial hemp products evaluated in this report.

Conceptually, various levels of pilot trials can be funded. In our view, part of the ability to attract support from potential channel partners and large scale product end-users (see #4 above) is Alberta's ability to offer '*customer/investor specific pilot trails*'. We know that ARC has a very customer-focused approach to new product development and commercialization (e.g. with Tolko in wood products, in which we have been involved in the past). We are not aware if these are being offered by ARC at present with regard to hemp and other industrial fibres.

We believe that, in working with selected larger scale channel partners (processors) and end-users, that it will be important for ARC to have the to offer comparative testing of, for example, hemp as a replacement for flax in thermo-plastic composites and/or preparing test results for varying levels of polypropylene mixes with hemp and other industrial fibres. ARC's ability to provide impartial scientific analyses, in a close working relationship with the end-users' own R&D facilities and testing labs can help Alberta differentiate itself, and position Alberta favorably, with these potential partners. Thus adequate spending on technical support delivered by ARC will be vital.

Recommendation #5. With a view to achieving rapid industrialization of the industrial hemp growing and processing industry in Alberta, the GoA should position Alberta as a potential globally competitive supply region in this field by offering and providing (via ARC) '*customer/investor specific pilot trails*' and related technical support services to prospective channel partners and large scale end-users. The GoA also should ensure that adequate funding for the R&D and new product commercialization efforts is made available.

In terms of timing, we see that as an important pre-cursor activity to large scale investment attraction in industrial hemp growing and processing -and a key component of the strategic plan roll-out process discussed earlier.

7. Conclusions & Recommended Actions

International Technical Partnership Collaboration in Industrial Hemp

Outside Alberta, other jurisdictions (such as Manitoba, the U.K., Holland, France and Germany) have developed a significant level of expertise in growing and, in some cases, the processing and further manufacturing of industrial hemp. At universities and technical institutions, such as the University of Bangor’s research centre (Exhibits 64 and 65), researchers are supported by European Union funding – and are widely regarded as being at the cutting-edge of industry developments in Europe.

Their expertise is enhanced through close collaboration with industry manufacturing partners. To avoid the costs of repeating research findings already available, and to gain access to European technology and related expertise, it may be possible for Alberta to develop a similar levels of technical collaboration with these European centres of excellence in industrial hemp.

Exhibit 64



Woodbridge Associates photo: Courtesy of Gary Newman

Exhibit 65



Woodbridge Associates photo: Courtesy of Gary Newman

Woodbridge Associates Inc.
www.woodbridgeassociates.com

The materials provided in this document are copyrighted. All intellectual property rights are retained by Woodbridge Associates Inc., except in the case of materials, data and information referenced from third parties who retain their own copyrights and intellectual property, and who have been identified accordingly.

The materials provided in this document may not be distributed or transferred, copied in print or in electronic format , altered, modified or reproduced without the expressed permission in writing of Woodbridge Associates Inc.