WOOD ADHESIVES

A Market Opportunity Study

December 2007
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WOOD ADHESIVES MARKET STUDY

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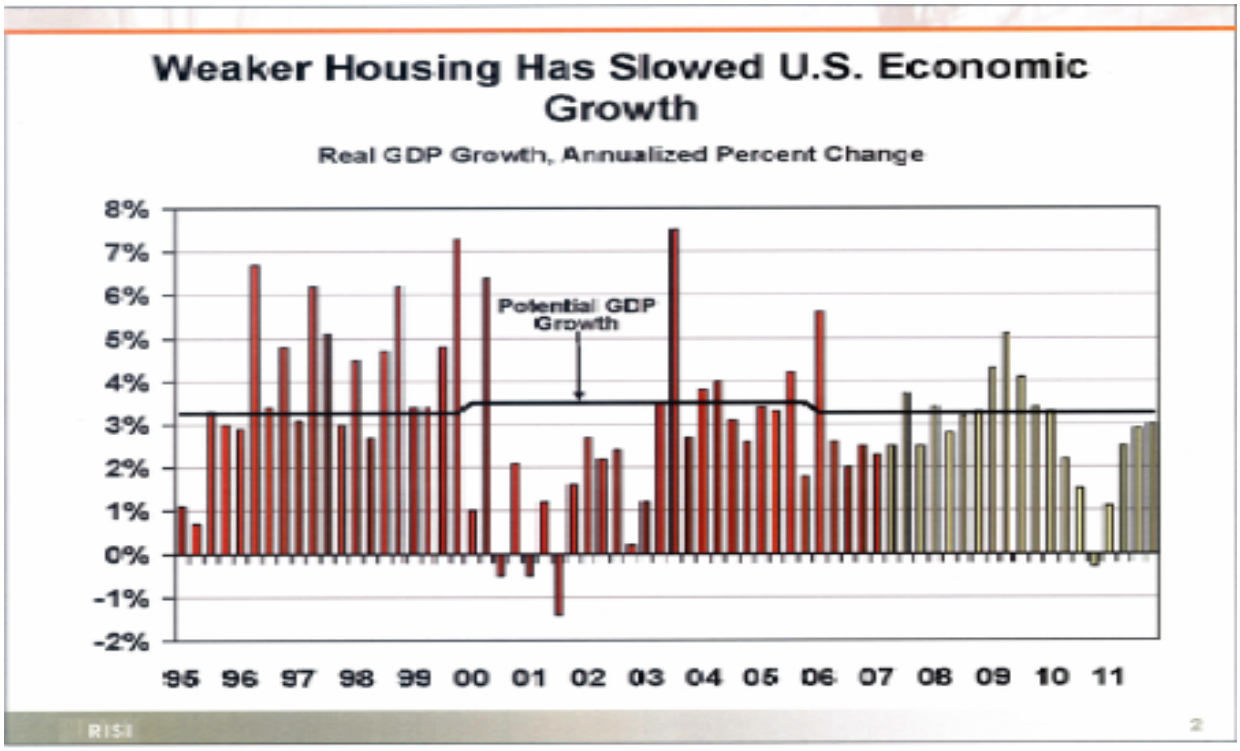
EXECUTIVE SUMMARY

Against the backdrop of a weak housing market and the current production status of several key wood composite panel markets, this study attempts to identify the current soy-based glue opportunities and how these opportunities can be captured. This study is particularly germane in light of increased soy meal/flour availability as more soy oil is processed to meet the growing biodiesel demand.

The macroeconomic issues of the U.S. economy are important to understand as they relate to the current and future status of the wood composite panel markets. The weaker housing market is a major factor in slowing the U.S. GDP from a 7.5% annual rate in 2003 to about a 2.5% rate in 2007 (Table 1). Excessive overbuilding occurred in the

TABLE 1

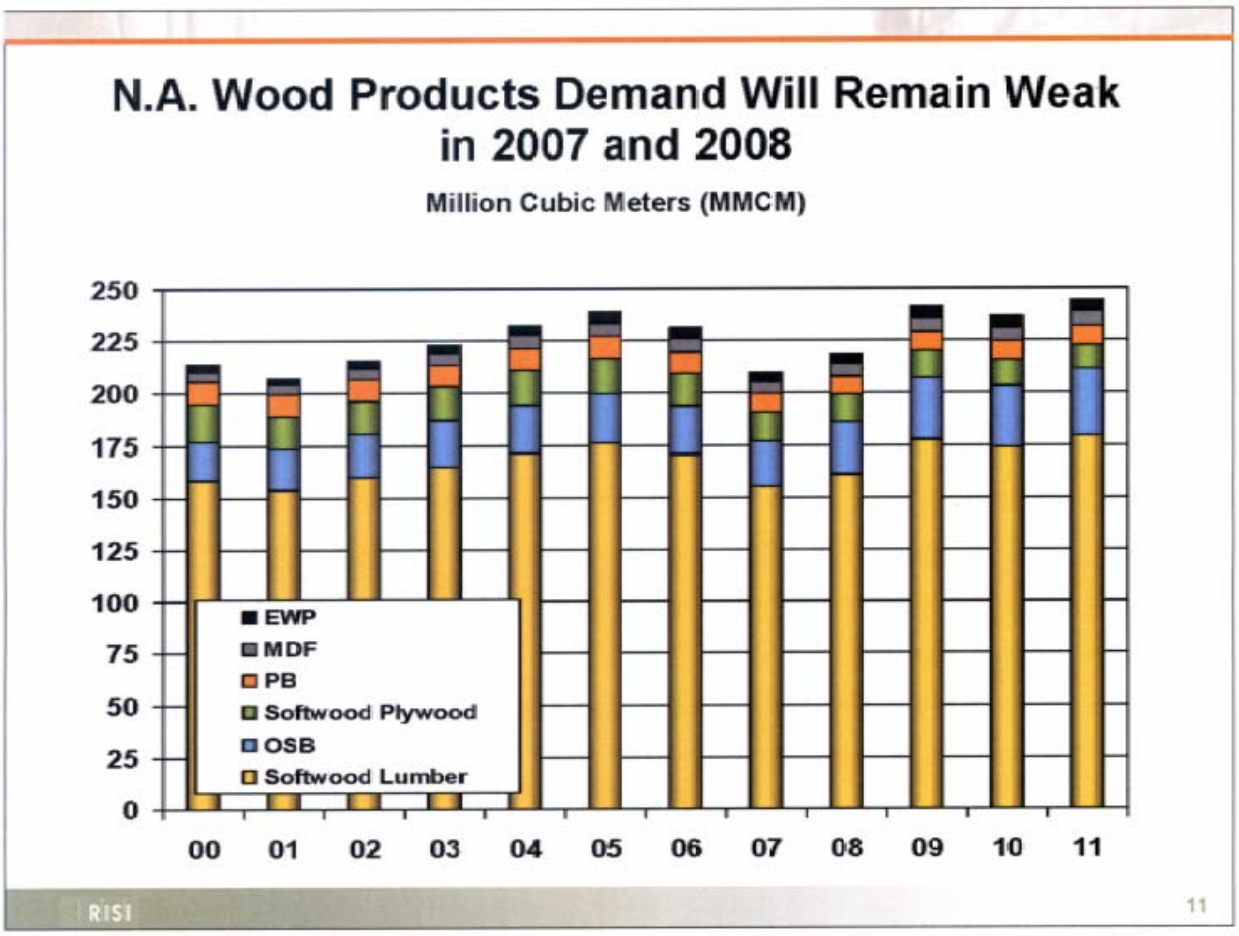


Based on RISI data

2003-2005 period causing a high inventory of unsold homes with little pent up demand, even with historically low interest rates of five or six percent. Many banks offered exotic and risky loans to lenders who had less than good credit. Some of these loans with balloon payments and/or variable interest rates can not be refinanced today due to tighter credit requirements requiring home owners to sell their houses. This glut of homes has caused existing home sales to decline and home price growth has slowed dramatically. The downturn in the construction market will cause consumption of

composite wood panels to decline in the short term and a rebound is not expected until 2009 (Table 2).

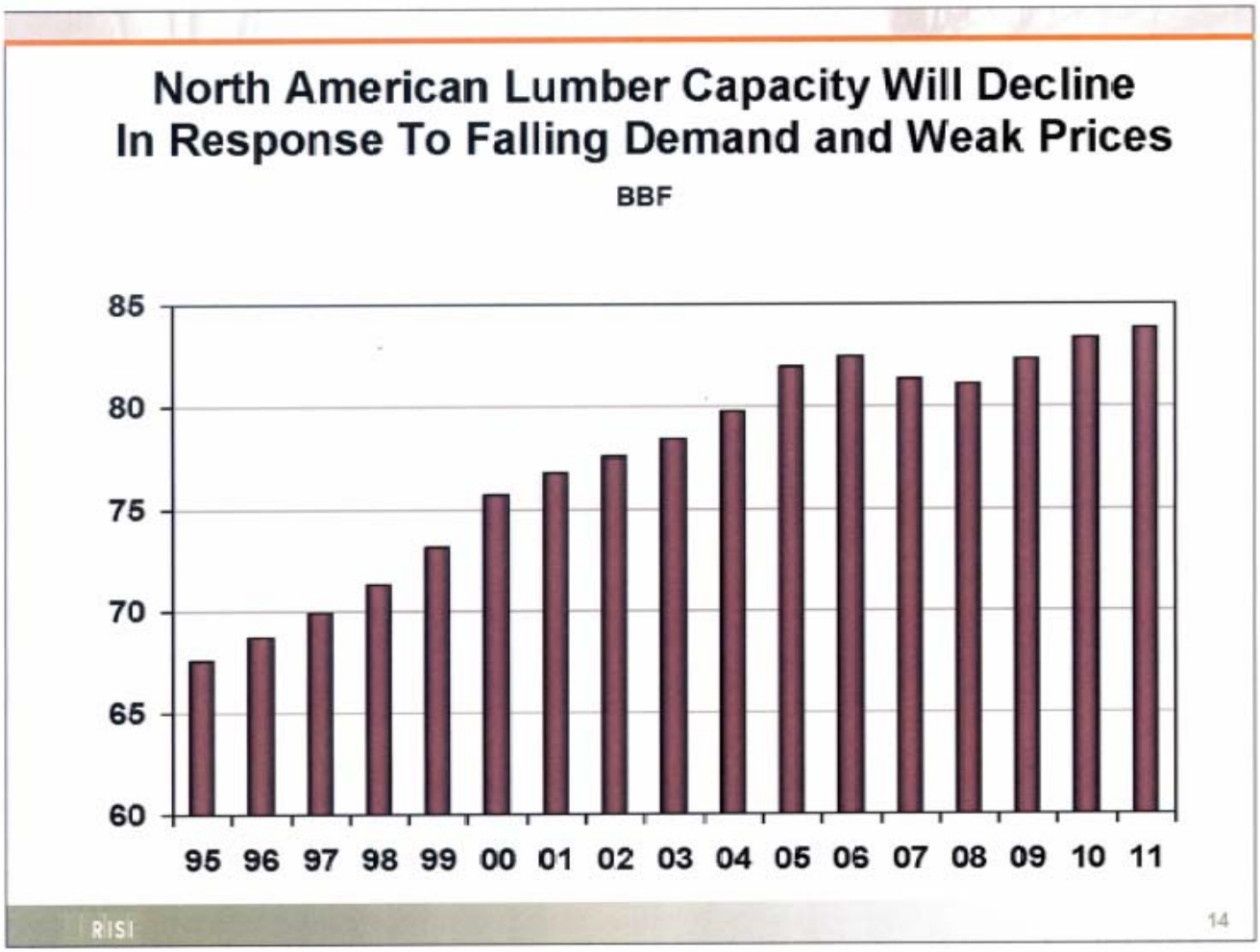
TABLE 2



Based on RISI data

On another note, limited forest fiber availability will impact the particle board and medium density fiberboard markets. Reduction in the North American timber production, which provides the majority of the sawdust, shavings and chips used by the particle board (PB) and medium density fiberboard (MDF) manufacturers, has caused a dip in available fiber. The lumber production is down due to the slump in housing starts (Table 3). This limited supply of fiber will increase wood costs for PB and MDF, which has caused production curtailment.

TABLE 3



Based on RISI data
BBF = billion board feet

Fiber availability is expected to be tightened in 2007. Improvement will occur in 2008 but remain below 2005-2006 levels. As mentioned before, a healthier rebound in housing is expected in 2009, which will improve fiber availability and moderate cost increases in the PB and MDF markets.

There are several promising soy-based adhesive opportunities in spite of this temporary weakness in the housing market. In 2004, the International Agency for Cancer Research reclassified formaldehyde from a suspect carcinogen to a known carcinogen. This began a flurry of technical work on non-formaldehyde containing resins to replace primarily UF in non-structural wood composite panel glues. In addition, the rising prices of phenol resins has afforded an opportunity for soy to replace phenol in phenol formaldehyde glues used in structural wood composite panels.

There are now five soy-based glues to be used in wood composite panels. Oregon State University began the industry development with soy/kymene resins to be used in

interior hardwood plywood. Other organizations such as Hexion Specialty Chemicals, Hercules/Heartland, LCB Worldwide and USM Corporation followed with their own respective soy-based technologies. A more detailed discussion of these resins is included in the section on soy-based resins. The future of soy-based adhesives rests upon the cost of soymeal/flour, petrochemical-based product pricing, technology development and regulatory/legislative actions.

It is difficult to accurately estimate the soybean opportunity in the wood composite area. After several years of commercial trials, soy meal/flour is only beginning to penetrate the wood composite glue market. Soy has begun market penetration in the interior hardwood plywood industry to provide a formaldehyde free glue line. The opportunity for soy-based glues in the wood composite industry is market dependent. For the particleboard and medium density fiberboard markets, the greatest interest is having a formaldehyde free resin to resolve the issue of formaldehyde emissions needed to meet current and anticipated regulatory demands and green initiatives such as the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™. For the oriented strand board (OSB) and structural plywood markets, formaldehyde emissions are of much lesser concern than reducing the cost of petrochemical resins such as phenol formaldehyde and melamines which are associated with the rising costs of natural gas and oil.

If we assume a 20% market share for soy-based resins in the wood composite resin business within 4-5 years after market introduction, the total soy meal/flour opportunity would be approximately 744 million pounds or 18.6 million bushels of soybeans.

INTRODUCTION

The objectives of this study are to:

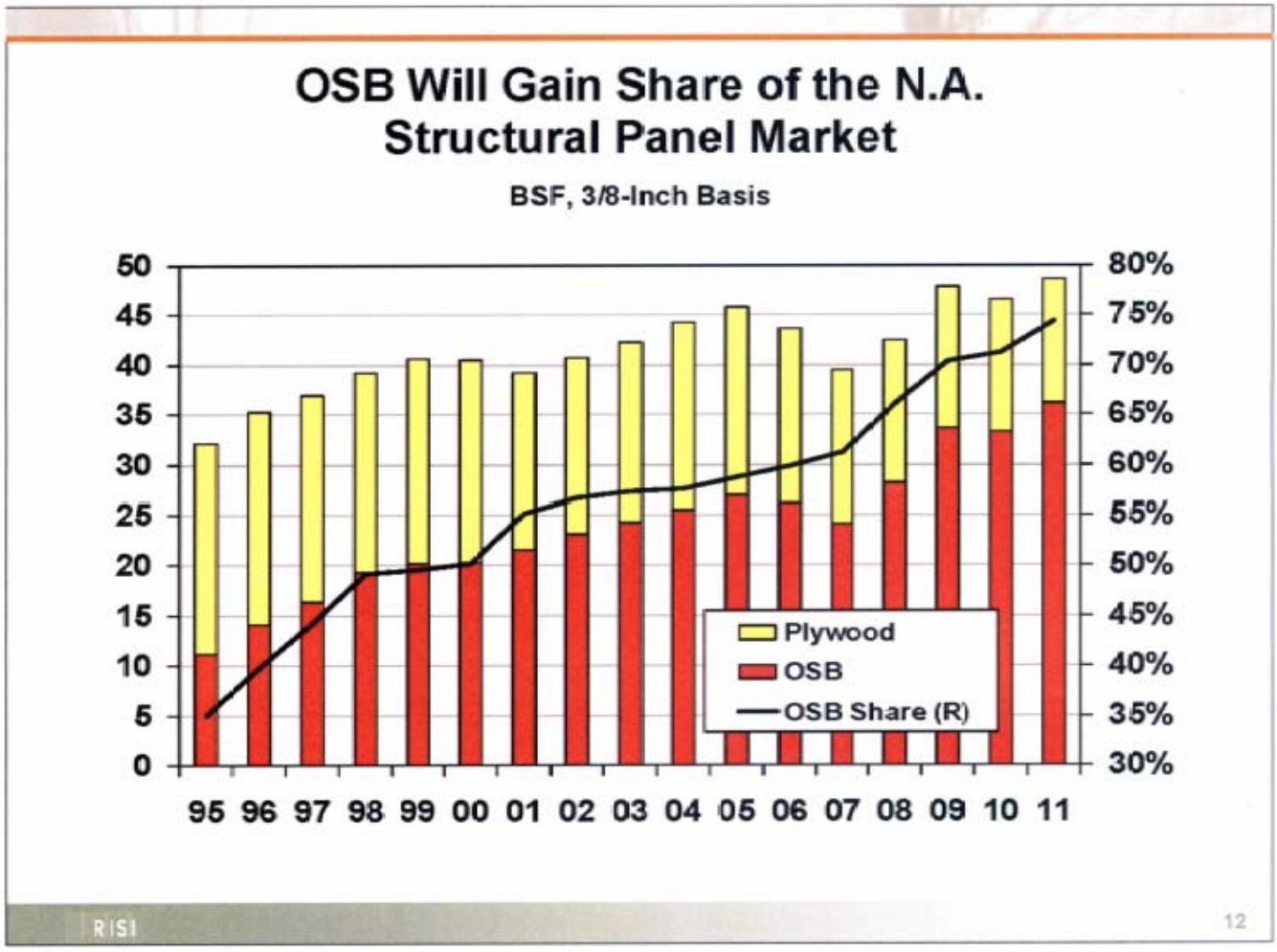
- Update the 1997 study on selected wood composite panel market segments in light of increased emphasis on soymeal/flour derivatives and opportunities in wood composite panel markets
- Revise the soybean market potential in existing and new markets in wood composite panels
- Provide recommendations for soy adhesives in these new selected wood composite panel markets
- Develop a strategy for short term commercialization in these markets

SITUATIONAL ANALYSIS

Overview of Composite Wood Panel Markets

North American Wood composite Panel demand will remain weak in 2007-2008. A rebound is expected in 2009 and 2010. In addition, the substitution of OSB for plywood will accelerate (Table 4). In response to falling demand and weak prices, the North American lumber capacity will decline in 2007 and 2008. New capacity start ups in OSB will compound the weakened OSB market (Table 5).

TABLE 4



Based on RISI data
BSF – billion square feet

TABLE 5

New N.A. OSB Mills Announced and/or Under Construction

Company	Location	Capacity (MMSF, 3/8-Inch Basis)	
Grant Forest Products	Manning, South Carolina	850	Start-Up, 2007 Q4
Louisiana-Pacific	Thomasville, Alabama	700	Start-Up, 2007 Q4
Tolko Forest Products	Slave Lake, Alberta	825	Start-Up, 2007 Q4
Ainsworth	Grand Prairie, Alberta	600	Expansion, 2008 Q2
Huber Engineered Woods LLC	Swainsboro, Georgia	650	Start-Up, 2009 Q3
St. Lawrence F. P. (Ainsworth)	Lisbon, New York	550	Start-Up, 2009-2010 (?)
Ainsworth	Quesnel, British Columbia	750	Start-Up, 2010 Q2
Ainsworth	Manitoba	750	Start-Up, After 2010
Total Additions to Capacity		5,675	

RISI 16

Based on RISI data
MMSF = million square feet

Wood Composite Panel Segments Discussion

TABLE 6

Production & Adhesive Overview by Market Segment

MARKET SEGMENTS	2006 PRODUCTION US/CANADA	2011 PRODUCTION US/CANADA	PRIMARY ADHESIVE	ADHESIVE 2006 BILLION LBS **	SOY POTENTIAL 2011 MILLION BUSHELS*
STRUCTURAL PANELS					
OSB (Bill sq. ft. 3/8" basis)	26.5	35.7	PF, MDI	1.04	4.5
Softwood Plywood (Bill sq. ft. 3/8" basis)	16.0	10.8	PF	0.49	1.2
NON-STRUCTURAL PANELS					
PB (Bill sq. ft. 3/4" basis)	5.4	4.9	UF	1.3	7.5
MDF (Bill sq. ft. 3/4" basis)	2.63	2.65	UF	0.89	5.4

*****Sources are APA Structural Panel and Engineered Yearbook, RISI Annual Historic Data, Industry Estimates
*dependent upon technology and cost
** 100% active basis

The product segments discussed in this report are wood composite panels such as Oriented Strand board, Plywood, Particleboard and Medium Density Fiberboard, as well as emerging wood products markets. At the time of writing this report, the markets using UF resins in non-structural panels offer the quickest gains for soy-based adhesives, with soy-based glues in structural panels representing a longer term opportunity.

The product segments with the largest potential volume for soy adhesive substitution are in the non-structural panels such as the particle board and medium density

fiberboard market segments. Not only is the production of these materials large, the adhesives in use are often high solids glues with a minimal amount of water so as to not disrupt the high pressure and high temperature process with excessive amounts of water. The interior hardwood plywood segment is quite small relative to the other wood composite panel sections but is significant to this study because it represents a starting point with soy-based glues in wood composites. About 35 million pounds of soy-based formaldehyde free glue systems are in use today representing about 70% of the glue potential in this segment.

TABLE 7

2006 North American Production by Geographical Region & Number of Mills

	U.S.		CANADA		TOTAL	
	VOLUME	NUMBER OF MILLS	VOLUME	NUMBER OF MILLS	VOLUME	NUMBER OF MILLS
OSB (BSF 3/8”)	15.0	9	11.5	11	26.5	20
Plywood (BSF 3/8”)	13.4	36	2.6	9	16.0	45
Particleboard (BSF 3/4”)	4.2	8	1.2	4	5.4	12
Medium Density Fiberboard (BCF 3/4")	1.86	16	0.77	7	2.63	23

Sources are APA Structural Panel and Engineered Yearbook, RISI Annual Historic Data Industry Estimates

STRUCTURAL PANELS

The term structural panels refer to oriented strand board and softwood plywood. Their main use is in light weight construction where they provide the rigid envelope that ties the other structural elements of wood framed buildings together. High strength, stiffness and resistance to moisture are the main performance criteria.

Originally this function was performed by 12 inch wide boards, but when moisture resistant phenolic resins became available in the 1930’s, 4 foot wide plywood panels made of sheets of veneer became more economical. In turn, plywood was challenged by strand board technology in the 1970’s. Since then the market has been dominated by these two products.

Oriented Strand Board (OSB)

OSB is a performance rated wood composite panel manufactured using wood chips or strands with an adhesive binder. The strands are layered and oriented at right angles to develop maximum stability and strength. The strands and binder are bonded together in a hot press under both heat and pressure.

TABLE 8

OSB History & Forecast

OSB (U.S. & Canada)	2001	2006	2011	01 – 06 AGR	06 – 11 AGR	Soy Potential Million Bushels 2011
Production (Billion sq. ft. 3/8" basis)	21.5	26.5	35.7	4.6	6.9	
Adhesive (PF, MDI) (Billion pounds)	0.86	1.04	1.42	4.2	7.3	
Soy Adhesive Potential (Million Bushels)						4.5

OSB is produced using primarily liquid phenol formaldehyde resins at about 40-45% solids. Small amounts of dry PF resins are also used, as well as isocyanates. The OSB manufacturers apply resins as received from the manufacturers.

The current formaldehyde free soy-based resins are too high in viscosity for use in sprayable applications needed for making OSB. Much work is being done to develop the proper viscosity for this application. The USB is supporting research into this challenge at Oregon State University which was the original inventor of soy-based formaldehyde free glues used in interior hardwood plywood. The other challenge is to develop these soy-based glues at a cost advantage to conventional PF resins as PF does not emit formaldehyde into the atmosphere in the marketplace, so economics, not formaldehyde emissions, will be the primary driver for change.

Softwood Plywood Panels

Plywood is the original performance rated composite board. It is composed of layers of thin wood veneers arranged in perpendicular layers and bonded together with an adhesive. Layers of the veneer are coated with adhesives and combined in a hot press.

Intrinsically plywood panels are more costly to make than OSB. Plywood has the advantage of familiarity and appearance together with some properties – thickness and swelling in particular – that are considered superior by many.

TABLE 9

Softwood History & Forecast

Softwood (U.S. and Canada)	**2001**	**2006**	**2011**	**01 – 06 AGR**	**06 – 11 AGR**	**Soy Potential Million Bushels 2011**
Softwood (U.S. & Canada) (Billion sq. ft. 3/8")	17.4	16.0	10.8	-1.8	-6.6	
Adhesive Usage (PF) (Billion pounds)	0.53	0.49	0.32	-1.8	-7.0	
Soybean Adhesive Potential (Million Bushel)						1.2

The same type of PF resins used in OSB are suitable for use in softwood plywood since both panels have similar structural requirements. The only difference would be that the viscosity of these materials is more paste-like in consistency for roller coating on the veneers in the case of plywood.

There is a small market for soy to be used as a protein stabilizer to replace animal blood in foamed plywood glues. Soy is more environmentally friendly than animal blood and less odiferous. Several panel mills use foamedglue in plywood production because less glue is needed than normally required for conventional roller coated glues.

NON-STRUCTURAL PANELS

Particleboard

Particleboard is a panel normally composed of discrete particles or pieces of wood in contrast to fibers, combined with an adhesive resin or other binder. The particles are bonded together under heat and pressure in a hot press and formed into a board. Typically low quality wood products such as sawdust and planer shavings are used in production. Particleboard is restricted to interior applications because it has poor water resistance and weathering properties.

TABLE 10

Particleboard History & Forecast

Particleboard (U.S. & Canada)	2001	2006	2011	01 – 06 AGR	06 – 11 AGR	Soy Potential Million Bushels 2011
Particleboard (Billion sq. ft. 3/4")	5.8	5.4	4.9	-1.8	-1.8	
Adhesive Usage (UF) (Billion pounds) (100%)	1.4	1.3	1.2	-1.8	-1.8	
Soy Adhesive Potential (Million Bushels)						7.5

The most popular adhesive used for particleboard production is urea formaldehyde. It is relatively inexpensive, readily available and has sufficient properties for indoor applications. However, formaldehyde has been classified as a known carcinogen and many mills are seeking to replace UF resins, which emit formaldehyde, with products like soy-based formaldehyde free resins. There are soy-based resins capable of replacing UF, but costs to use soy based resins may vary from mill to mill.

Medium Density Fiberboard (MDF)

MDF is composed of uniformly small particles and is of consistent density. The density of MDF ranges from 31 to 55 pounds per cubic foot. MDF is produced through the use of heat and pressure in a hot press. Continuous presses are used in new plants for MDF production of various thicknesses. Low cost materials such as sawdust, planer shavings and pulp chips are used in its manufacture.

Urea formaldehyde is the primary resin used in MDF production. MDF is considered an interior, non-structural product. Its major uses include furniture and cabinets.

TABLE 11

MDF History & Forecast

MDF (U.S. & Canada)	2001	2006	2011	01 – 06 AGR	06 – 11 AGR	Soy Potential Million Bushels 2011
Production (Billion sq. ft. 3/4")	2.2	2.63	2.65	3.9	0.0	
Adhesive Usage (UF) (Billion pounds) (100%)	0.72	0.89	0.86	4.7	0.7	
Soy Adhesive Potential (Million Bushels)						5.4

As in particleboard, urea formaldehyde is the most popular resin used in MDF production since it is suitable for interior applications such as furniture and cabinets. Formaldehyde-free soy-based resins will also be popular in this market once the issues of cost and performance are resolved.

EMERGING MARKETS

Heat Resistant Adhesives (HRA)

Effective February 28, 2007 finger jointed lumber in Canada may use the heat resistant adhesive label (HRA) if the assembly passes ASTM E110. This test rates the fire resistant properties of the glue line in structural assemblies in terms of number of minutes before melting. The various fire service organizations are concerned that structural assemblies in buildings collapse before the word burns because the glue line softens first. Tests in finger joint assemblies rate PRF at one hour, polyurethane at fifty-one minutes and poly vinyl acetate at forty-nine minutes, proving there is a difference among adhesives.

The USDA Forest Products Labs under Chuck Frihart has done some preliminary work indicating soy has limited thermal softening under heat suggesting it has good heat resistance. The emerging market for this heat resistant property would be primarily in engineered wood products such as finger joints, I-beams and joists.

Enzymatic Technology

Traditionally soy hydrolyzates were developed to co-react with high performance resins such as phenol formaldehyde for potential use in oriented strand board and softwood plywood. Theoretically, the soy hydrolyzates would be used to reduce cost without sacrificing performance in composite wood panels.

The conventional way to produce soy hydrolyzates was with either soy meal or flour involving extended high temperature and pressure in the presence of ammonia. These high caustic conditions are less than ideal for making a chemical and were costly so that any raw material cost advantages were offset by an expensive process.

Iowa State is being supported by the USB to use enzymes to make soy hydrolyzates in a more user friendly and more cost effective process, thereby restoring the value proposition lost by the traditional way to make the chemical.

New Soy-Based Green Composites

E2e Materials of Ithaca, New York is developing a new soy protein and renewable plant fibers composite particle board and medium density fiberboard. The composites are described as a cost competitive formaldehyde free solution to traditional wood composite particle board and medium density fiberboard. The e2e material is fully benign and contains no petrochemical products. The proprietary technology claims a high strength to weight ratio which can result in 65% weight reduction without loss of performance. Less material can equate into less energy required to produce particleboard and medium density fiberboard.

CURRENT SOY-BASED RESINS

Current soy-based technology for use in composite wood panels centers around several different systems. All of these technologies were developed to produce lower cost and/or more environmentally friendly systems.

The first system is soy phenol formaldehyde wherein soy flour is converted to a soy hydroylzate which is in turn co-reacted with phenolic resin. Low cost soy meal/flour can be substituted for up to 40% of the more expensive phenolic component for use in softwood plywood, OSB and engineered wood products. The process provides a method for converting soy meal/flour into a soy phenol formaldehyde resin with properties comparable to a phenol formaldehyde resin.

The second resin involves the use of soy flour in foamed glue extruded systems for laminating plywood veneers. In this system, soy flour is substituted for animal blood to be used as a foaming agent for phenol formaldehyde resins. The main benefit for foamed glues over other application systems is the savings in resin usage. Other benefits are reduced glue spread, reduced glue waste and minimal cleanup time. Reduced resin content also results in reduced formaldehyde emissions. The soy flours have been introduced to replace animal blood as a foaming agent because it is cost competitive, avoids odors and is safer to use.

The most recent technology involves the use of soy meal/flour in formaldehyde free adhesives developed to minimize the amount of formaldehyde emitted from composite wood panels. In 2004, the International Agency for Cancer Research announced that formaldehyde was a known carcinogen and many composite wood panel manufacturers looked for alternatives to current UF resin systems.

In 2005, Columbia Forest Products announced the first use of formaldehyde free glue when it converted from the use of urea formaldehyde adhesives to a patented soy system cooperatively developed by Columbia, The College of Forestry at Oregon State University and Hercules International. Hercules was granted a worldwide license to use this Pure Bond™ technology in the wood panel market. Columbia was awarded a license to utilize this patented adhesive system on an exclusive basis for all North American decorative panel businesses which included interior hardwood plywood and particle board. In addition, Hercules has granted Columbia permission to be the exclusive seller and application specialist for the Pure Bond™ technology in interior decorative panels. These soy adhesive systems are easy to prepare in the panel mills and do not require harsh reaction conditions.

Other resin companies have developed low formaldehyde or formaldehyde free glue systems with soy to meet the challenges of regulatory and environmental issues. Hexion Specialty Chemicals has developed a soy/PVA system which is claimed to be formaldehyde free for use in interior hardwood and particleboard.

Hercules Incorporated and Heartland Resource Technologies LLC have formed a joint venture named H2H Innovations to introduce new soy-based formaldehyde free resins to the interior decorative wood composite panel market as well as new soy-phenol co-adhesives for the OSB market. The joint venture is expected to combine the soy expertise of Heartland with the crosslinking experience of Hercules. Some of the early work by Heartland was supported by USB funding.

CURRENT COMPETITIVE RESINS

The major adhesive resins used for wood composite panels contain phenol or urea, plus formaldehyde. These chemicals are combined for use as binders or adhesives for the manufacture of the various wood panels.

Formaldehyde is made from methanol, which is made from natural gas. Phenol is derived from benzene and cumene, which is made from crude petroleum and propylene, which is made from natural gas in most of the world. Urea is a product of ammonia, which is also primarily made from natural gas and carbon dioxide.

Substantial amounts of urea are still produced in the U.S., but ammonia domestic production has fallen significantly. Ammonia is imported from around the world where natural gas is abundant and alternative demand is very low. Urea prices have grown from $0.05 per lb. in 2002 to $0.17 per lb. in 2007. Formaldehyde pricing was flat through 2005. In August of 2006, several major methanol producers declared force majeure and prices climbed from $1.00 per gallon to $1.70 per gallon. At the end of 2006 the force majeure was lifted and current methanol prices went back to $1.00 per gallon, thereby stabilizing formaldehyde pricing at 2005 levels. However, in October of 2007 a major European manufacturer declared force majeure and an Argentine supplier cut off natural gas to make methanol thereby driving prices back to their current $1.70 per gallon. Phenol is running at historically high prices of $0.73 per pound from $0.56 per pound in 2005 due to increases in the price of crude oil and shortages of benzene which led to higher prices for cumene, a key feedstock for phenol. Forty percent of all formaldehyde use is in UF and PF wood glues. (All raw material prices have been quoted from ICIS pricing sheets).

Soybean meal prices have been flat until recently when the cost of cornmeal increased due to increased demand for corn ethanol driving soymeal prices upward from $0.105 per pound in January 2007 to $0.15 cents per pound today.

ISSUES ANALYSIS

Barriers to Entry

The composite wood panel industry remains a capital intensive, high volume commodity business. Therefore, they are generally risk averse to trialing new raw materials unless the incentive is well defined and cost savings are significant. Any mistakes in the

process can produce thousands of dollars of economic waste in time, energy and finished product. The competitive resins are well established and it is not uncommon to make changes in suppliers for a few cents per pound to save money. Soy in composite wood panels is in the early stages of adoption and will have to meet either significant economic hurdles or solve regulator/environmental issues.

Cost versus Petrochemical Resins

Soymeal prices have increased about 40% since the beginning of 2007 This reflects reduced soy production with ending stocks down 61% in the face of record domestic meal consumption. Until the recent spikes in methanol prices, the soy-based glues were being sold at a cost premium to UF for interior hardwood plywood. However, with today's prices for methanol, the soy-based resin system should be more competitive. This cost issue is less important in UF produced composite wood panels where formaldehyde emission needs to be reduced or eliminated as opposed to OSB where cost will be the driver for change. The PF resins used in OSB tend not to emit formaldehyde in the market place if they are properly prepared.

Unmet Needs

Most of the issues related to the use of soy-based adhesives revolve around viscosity and loss of productivity. Some of the initial soy-based adhesives for interior hardwood plywood were too high in viscosity for applications requiring a sprayable product as in the case of particleboard and OSB. The Pure Bond™ products invented for interior hardwood plywood are paste-like in consistency and not thin enough to be sprayable. The productivity issue relates to soy-based resins being slower to cure than competitive resins. This requires more time in the presses which slows production.

Also, the initial soy/PF co-resin products were not economically attractive enough to encourage trials in a risk-adverse business. There is considerable work going on in PB and OSB to both lower costs and reduce viscosity of the glue; work needs to be started for medium density fiberboard.

Legislation/Regulatory Issues

In 1995, the International Agency for Cancer Research determined that formaldehyde should be listed as a suspect carcinogen. Further testing was conducted and in 2004 formaldehyde was reclassified to a known carcinogen, specifically for nasal cancer. As an example to illustrate this problem, on July 19, 2007, Mary DeVany testified before the Committee on Oversight and Government Reform in the U.S. House of Representatives that FEMA had a major problem with formaldehyde emission within the trailers used to house Katrina hurricane victims. She reported that the levels of formaldehyde emissions in these trailers were more than 400 times the level that the Agency for Toxic Substances and Disease Register claims is harmful within a 365 day exposure period.

These and other initiatives set in motion state reviews of health hazards from formaldehyde emissions for their citizens. The State of California has established the lead with the announcement that they want their citizens exposed to no formaldehyde if possible. They subsequently proposed two of the most stringent requirements for formaldehyde content in composite wood panels. They have promulgated two levels of formaldehyde for future production and import of composite wood panels containing formaldehyde-based glues. Phase 1 is set to be introduced in 2009 and most urea formaldehyde resins can comply with Phase 1. However, Phase 2 to be started in 2011-2012 cannot be met with current UF technology. There are no problems with PF resin used in OSB because PF tends not to emit free formaldehyde.

Based upon California's intentions, Hercules licensed soy-based formaldehyde free technology from Oregon State University to be used by Columbia Forest Products in their interior hardwood decorative paneling. All of their mills have converted to this new soy-based resin which has resulted in about 35 million pounds of new soy flour annual consumption.

It is widely regarded that other states will follow the State of California's stringent requirements for free formaldehyde in composite wood panels. In addition, most mills will comply because it is impractical and too expensive to segregate production for the State of California.

Environmental Issues

Based upon the State of California's strict requirements for formaldehyde in composite wood panels, the Green Building Council, and specifically the LEED program, promotes formaldehyde free panels as being more environmentally friendly. Any composite wood panels are free from testing if they contain no formaldehyde in their glues. In addition, LEED gives credit for wood composite panels made from glues with no added formaldehyde.

The use of formaldehyde free resins in composite wood panel production also reduces methanol emissions a consideration in those states where such emissions are monitored.

At the end user level of the value chain, Home Depot is requiring their wood composite panel suppliers to provide products which meet European 1 requirements for reduced levels of formaldehyde. IKEA is proposing that their furniture have a maximum formaldehyde level of .07 ppm, which is lower than the phase 1 requirement proposed by the California Air Resources Board (CARB).

RECOMMENDATIONS

The following list of recommendations is offered to support the path forward in both the short and long term commercialization of soy-based adhesives.

- Continue to support product development into soy containing formaldehyde free adhesives in OSB, plywood and particleboard as this remains a major regulatory or cost issue for the wood composite panel industry.
- Identify a project for Heat Resistant Adhesives in Composite Wood Panels as identified by the USDA Forest Products Laboratories as an emerging safety issue for wood composite panels and other engineered wood products.
- Identify the characteristics of soybean meal/flour that affects the properties of wood adhesives in order to insure their optimum performance
- Continue the Soy Protein TAP program as a means of broadcasting success stories about soy-based glues and to identify new research opportunities.
- Continue small task force/customer meetings to discuss current and emerging technical issues
- Continue to attend the major composite wood panel tradeshows and technical seminars such as the Forest Products Society meeting, International Wood Composites Symposium and the Adhesives and Sealants Council (ASC) meeting in order to remain current about the interest in soy-based glues and any regulatory/legislative/environmental issues which may impact this business.

COMMERCIALIZATION STRATEGY

Soybeans will journey through many hands as they travel from the farmers to the final wood composite panel user. The secret to success is to promote the performance, economic and environmental value that soy contributes to wood composite value chain show below.

Farmers	USB, State Soybean Councils
Soybean Processors	ADM, Bunge, Cargill, Dupont, etc.
Adhesive Companies	Georgia Pacific, Arclin, Hexion, etc.
Panel Mills	Georgia Pacific, Louisiana Pacific, Weyerhaeuser, Boise Cascade, etc.
End Users	Builders & Consumers reached through Lowes, Home Depot, etc.

The most important strategies to pursue in maximizing soy in the value chain are to:

- Identify timely soy-based glue projects to be sponsored by the USB which meet needs expressed by the wood composite panel industry.
- Assist in connecting resin companies and panel mills with new soy-based glue technology sponsored by the USB.

- Display new composite wood panels made with soy-based glues at key tradeshows (Green Build Show, International Coatings Exposition, The International Builders Show, etc.).
- Publicize commercial successes in industry trade journals , biobased magazines and periodicals.

APPENDIX

POTENTIAL COMMERCIAL PARTNERS

A) OSB Producers (North America)

Company	Number of Mills
Ainsworth Engineered L.L.C.	3
Ainsworth Lumber	3
Canfor – LP	1
Canfor Corporation	1
Footner Forest Products	1
Georgia Pacific	6
Grant Allandale	1
Grant Forest Products	2
Huber Engineered Woods	5
Jolina Capital	1
Kruger	1
Langboard	1
Louisiana Pacific	17
Marto Partnership	1
Norbond	9
Tembec	1
Tolko Industries	3
Weyerhaeuser	9

B) Plywood Producers (North America)

Company	Number of Mills
Ainsworth Lumber	1
Atcon Plywood	1
Bessemer Plywood	1
Boise Cascade	6
Canfor Corporation	2
Chester Wood Products	1
Coastal Plywood	1
Colville Indian Power and Veneer	1
Commonwealth Plywood	1
DSD Lumber	1
Eagle Veneer	1
Emerald Forest Products	1
Federated Cooperative	1
Freres Lumber	1
Georgia Pacific	22
Hardel Mutual Plywood	1

Hood Industries	2
Hoquiam Plywood	1
Hunt Plywood	2
International Paper	1
K-Ply	1
Louisiana Pacific	1
Martco Partnership	1
McKenzie Forest Products	1
Moncure Plywood	1
Murphy Plywood	1
Natron Wood Products	1
Olympic Panels Products	1
Pacific Wood Laminates	1
Panel Products	1
Plum Creek	2
Potlatch	1
Richmond Plywood	1
Rosboro Lumber	1
Roseburg Forest Products	3
Scotch Plywood	1
Southern Veneer	1
Stimson Lumber	1
Swanson Group	1
Textured Forest Products	1
Timber Products	3
Tolko Industries	2
West Frazier Mills	3
Weyerhaeuser	3

C) Particleboard Producers

Company	**Number of Mills**
ATC Panels	2
Boise Cascade	1
Canpar Industries	1
Colllins Products	1
Fibratech Manufacturing	1
Flakeboard	1
Florida Plywoods	1
Marchfield Door Systems	1
Merilatt Industries	1
Northern Engineered Wood Products	1
Panolam Industries International	1
Potlatch Forest Products Corporation	1
Roseburg	4
Sierrapine	2

Tafisa Canada and Company Ltd.	1
Temple Inland	3
Timber Products Company	1
Unibond Canada Inc.	2
Webb Furniture Enreprises Inc.	1

D) MDF Producers

Company	**Number of Mills**
ATC Panels	2
Bassett Fiberboard	1
CMI/Craftmaster Manufacturing Inc.	1
Del-Tin Fiber LLC	1
Flakeboard	4
Georgia Pacific	1
Great Lakes MDF LLC	1
Langboard Inc.	1
Norboard Industries Inc.	1
Pan Pacific Products, Inc.	1
Plum Creek MDF Inc.	1
Roseburg	1
Sierra Pine	2
Temple Inland	1
Uniboard Canada Inc.	1
Unilin US MDF	1
West Frazer Mills	2

E) Resin (glue) Suppliers

Adhesive companies play a critical role in the commercialization of soy adhesives. They maintain very close relationships with the wood composite companies and call in-depth to sell their services. They are successful because they are responsive to the wood composite company's needs. The adhesive companies will provide the required development and support needed to help the wood composite companies utilize the soy-based adhesives.

There are currently three resin companies supplying the majority of the adhesives to the wood composite panel manufacturer. All three companies supply a complete line of UF and PF resins needed to make wood composite panels and have approximately equal market shares in the industry, accounting for about 90% of the total wood composite adhesive requirements.

Company	**Location**
Georgia Pacific	Decatur, Georgia
Dynea (ARCLIN)	Springfield, Oregon
Hexion	Columbus, Ohio

There are also a small number of resin suppliers such as Huntsman, Dow and BASF providing specialty glues such as melamine-formaldehyde and pMDI (polymeric diphenylmethane diisocyanate). Melamine modified resins are used to improve durability and moisture resistance and to scavenge formaldehyde emissions. However, these resins are considerably more expensive than either UF or PF resins and therefore find limited applications. pMDI offers rapid cure rates, zero added formaldehyde and reduced panel thickness swell, but on a solids basis it is the most expensive of the wood panel glues. These specialty resins combined account for only 2-3 percent of the resins consumed by the wood panel industry.