Go Virginia Region 3 Council Draft Report

September 26, 2018

Prepared by GENEDGE/RTI and SPDC

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Key Regional Findings / Recommendations from HVWP Study

I. The Wood Industry needs work force development assistance for sustaining its current and potential future market demands. The need spans throughout the value chain based on direct employer feedback: Harvesters → Sawmills →Manufacturers

Recommendation: Council commission additional resources for further study of both apprentice and academic opportunities/needs

Potential Partners: IALR, SVHEC, local EDC's (incl. Brunswick, Halifax, etc.) and Community Colleges (DCC, PHCC, SVCC, etc.), sub-sector employers (Harvesters/Loggers, Sawmills, Wood Manufacturers)

II. The Wood Industry needs higher value applications for current wood waste (2.4MT/year)

Recommendation: Council support the creation of additional manufacturing jobs through both new and ongoing business attraction efforts(i.e. Enviva).

Recommendation: Council recommend regional EDC engagement/awareness of longer term (>3 years) biofuels efforts currently under investigation in Commonwealth of Virginia

Key Regional Findings / Recommendations from HVWP Study

III. The Wood Industry needs further entry into structural engineered wood products that have growing market demands (incl. TMW and CLT)

Recommendation: Council commission an assessment of strategic Industrial Parks for TMW/CLT manufacturing readiness as a collaborative with the local/regional EDC (i.e. Halifax and/or Charlotte County IDA)

IV. The Wood Industry needs an ongoing, sustaining effort for continued business engagement of strategic investment opportunities based on developing market(s) demand

Recommendation: Regional economic development collaboration with Virginia Department of Forestry - currently starting a multi-year statewide market opportunity/prospect investigation

The opportunities considered include large markets and nascent markets with significant potential for growth.

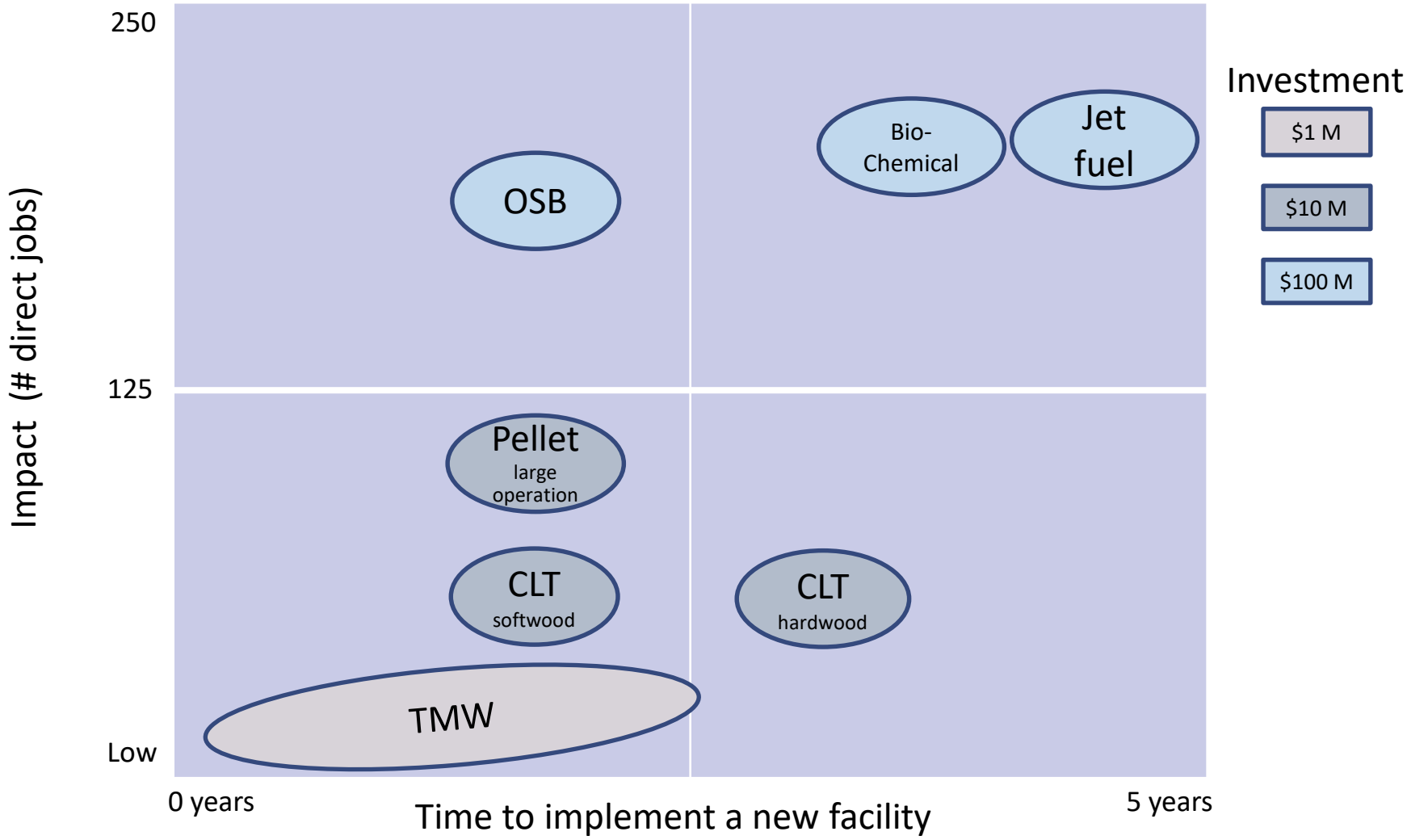
Product/Market	Global Market ($ millions)	US Market ($ millions)	Global CAGR	US CAGR
Raw wood waste*	NA	319	0%	
Biofuels	83,000	53,700	5%	3%
Oriented Strand Board (OSB)	7,400	4,900	8%	4%
Biochemicals	49,200	15,000	11%	12%
Wood pellets	3,700	210	15%	10%
Cross-Laminated Timber (CLT)	558	65	16%	14%
Thermally Modified Wood (TMW)	400	40	18%	13%

Note: Raw wood waste market size is an estimate of demand from Dominion Energy biomass-fired power plants in Virginia.*

Sources: multiple secondary sources and RTI Analysis

Executive Summary cont'd

PORTFOLIO ANALYSIS



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The Region 3 Council sought answers to two questions to inform their regional strategy.

1. What high-value opportunities match the resources available within the Region 3 footprint as related to high value wood products?

2. What does GENEDGE recommend for capturing high-value opportunities?

Background: Industry Experts

Project engaged wood product industry experts to understand the barriers and challenges of high value hardwood products.

Matt Aro
Scientist with Market-Oriented Wood Technology Program , Natural Resource Institute, University of Minnesota

Kalle Ekman
Stora Enso (former Danville employee)

Henry Quesada
Professor, Brooks Forest Products Center, Virginia Tech

Charlie Becker
Utilization and Marketing Manager, Virginia Department of Forestry

Rob Smith
Virginia Tech

Daniel P. Hindman
Professor, Wood Engineer,
VA Tech (researcher of Hardwood CLTS)

Dave Dayton
Director of Biofuels
RTI International

Michael Snow
Executive Director of the American Hardwood Export Council (AHEC)

Background: Regional Businesses and Partners

RTI INTERNATIONAL GENEDGE

Project engaged regional businesses and partners to understand the challenges of the wood industry

IKEA

HOPKINS LUMBER CONTRACTORS

GRIFFITH LUMBER COMPANY INC. Four Generations of Quality Hardwoods

VIRGINIA-CAROLINA FOREST PRODUCTS, INC.

VIRGINIA'S GROWTH ALLIANCE

PATRICK COUNTY VIRGINIA

Martinsville HENRY COUNTY VIRGINIA

BRIGHTER BOLDER BUSINESS HALIFAX IDA

New College INSTITUTE

Danville VIRGINIA Economic Development

SOUTHERN FINISHING COMPANY

BLUE RIDGE FIBERBOARD

Pittsylvania County Virginia

SOUTHERN VIRGINIA HIGHER EDUCATION CENTER Opportunity Lives Here

Southern Virginia REGIONAL ALLIANCE

AXXOR

SOUTHSIDE VIRGINIA COMMUNITY COLLEGE

Mecklenburg COUNTY, VIRGINIA Your Path to Profit.

Ten Oaks

HUBER ENGINEERED WOODS

storaenso

GP Georgia-Pacific

Jones Building Systems Roof & Floor Trusses Storage Buildings

Toll Brothers

HOOKER FURNITURE

NOVEC

WestRock

TYTON BioSciences

LAMINATE TECHNOLOGIES

CITY OF EMPORIA 1967 VIRGINIA

Lignetics

Welcome to BRUNSWICK COUNTY

IVC

CHARLOTTE COUNTY Virginia

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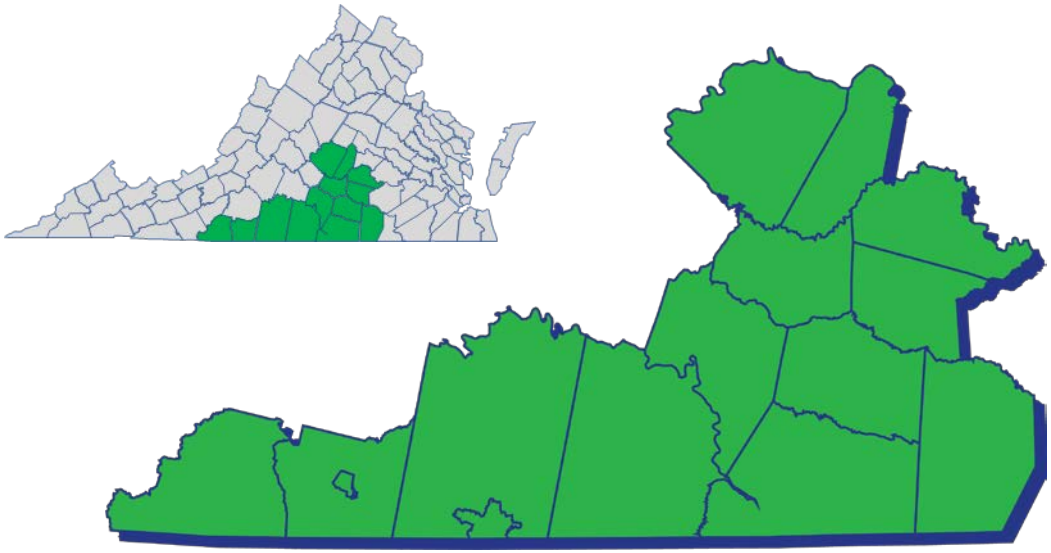
The geographic focus was Region 3 of the Commonwealth of Virginia; however, nearby resources were taken into consideration.

Region 3 consists of the cities of Danville and Martinsville; and the counties of Amelia, Brunswick, Buckingham, Charlotte, Cumberland, Halifax, Henry, Lunenburg, Mecklenburg, Nottoway, Patrick, Pittsylvania, and Prince Edward.

VA Adjacent Counties—Carroll, Floyd, Franklin, Bedford, Campbell, Appomattox, Nelson, Albemarle, Fluvanna, Goochland, Powhatan, Chesterfield, Dinwiddie, Sussex, Greenville

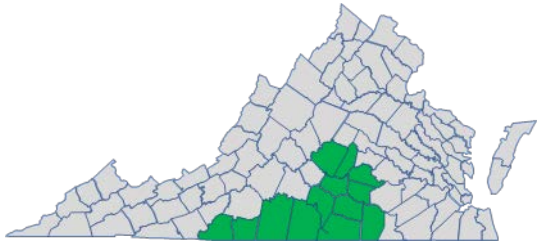
NC Adjacent Counties—Surry, Stokes, Rockingham, Caswell, Person, Granville, Vance, Warren, Halifax



Region 3

371,700 Total Population	153,265 Total Employment
5.3% Unemployment Rate	$35,000 Median Income Level

Region 3 has a strong forestry cluster.



Wood product assets in Region 3 include timber, saw mills, veneer operations, flooring including laminates, and wood fuel pellet plants.

Forestry is one of the region's strongest industry clusters within the natural resources category. Forestry posted an average wage of $54,000 in 2016, and has a location quotient of 15, which means that forestry employment in the region is about 15 times more concentrated than the national average. Employment in the forestry cluster grew 14% from 2006 - 2016, and is expected to grow an additional 15% from 2016-2026. Region 3 has had a long history of utilizing its hardwood forests for value-added new product development and engineering design, production and distribution. Continued growth in the wood products sector offer significant opportunities for Region 3 going forward.

Employment in targeted industry subsectors

Wood Product Manufacturing – 994 jobs

Truck Transportation – 679 jobs

Warehousing and Storage – 553 jobs

Forestry and Logging – 425 jobs

Source: Virginia Forestry Department

Region 3 has a mix of hardwood and softwood trees and generates a high volume of wood waste from wood product processing.

	Species group - Major				
County code and name	Total	Softwoods	Hardwoods	Softwood Tons	Hardwood Tons
Total	17,871,574,769	6,003,214,925	11,868,359,844	208,313,320	453,525,717
51007 VA Amelia	348,218,692	148,204,172	200,014,520	5,142,728	7,643,156
51025 VA Brunswick	614,145,673	351,566,520	262,579,153	12,199,461	10,033,939
51029 VA Buckingham	593,642,979	221,526,341	372,116,637	7,687,029	14,219,696
51037 VA Charlotte	439,287,557	172,986,574	266,300,983	6,002,685	10,176,161
51049 VA Cumberland	295,530,022	149,082,105	146,447,917	5,173,193	5,596,215
51083 VA Halifax	775,139,934	393,134,328	382,005,606	13,641,877	14,597,583
51089 VA Henry	451,587,197	167,787,365	283,799,831	5,822,271	10,844,845
51111 VA Lunenburg	444,861,309	221,439,086	223,422,224	7,684,001	8,537,635
51117 VA Mecklenburg	797,012,394	281,550,425	515,461,969	9,769,882	19,697,352
51135 VA Nottoway	315,586,091	163,476,649	152,109,442	5,672,688	5,812,559
51141 VA Patrick	626,912,625	58,066,652	568,845,972	2,014,930	21,737,315
51143 VA Pittsylvania	817,968,495	261,949,847	556,018,648	9,089,737	21,247,144
51147 VA Prince Edward	292,537,757	144,953,538	147,584,219	5,029,930	5,639,637

Source: Virginia Forestry Department

Region 3 has large quantity of hardwood and softwood wood waste.

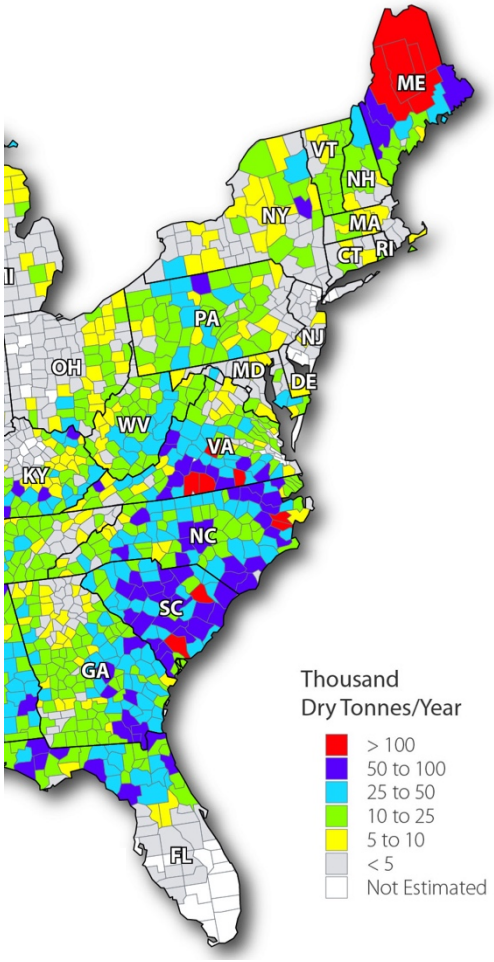


Table 12. ◆ Weight of bark and wood residue by type of residue, softwood, hardwood, and use , [user title]

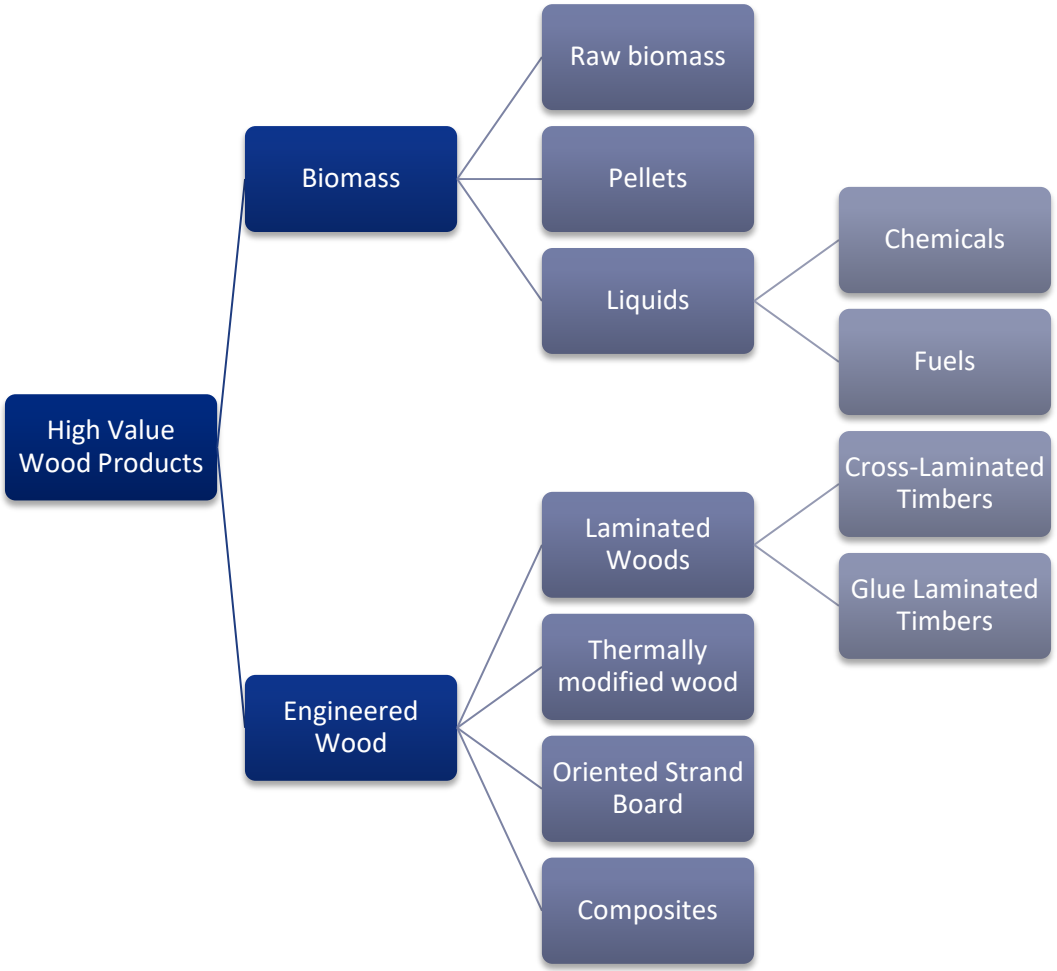
Source	Species Group	Fiber by-product	Fuel by-product	Misc by-product	Not used by-product	All by-products
				thousand dry tons		
Bark Residue	Softwood	0	308	97	0	406
	Hardwood	1	329	112	0	442
	Total	1.0	637.0	210.0	0.0	848.0
Wood Residue (coarse)	Softwood	353	51	77	1	481
	Hardwood	259	106	41	1	407
	Total	611.0	157.0	118.0	2.0	888.0
Wood Residue (fine)	Softwood	34	270	91	2	396
	Hardwood	9	191	52	1	253
	Total	43.0	461.0	143.0	3.0	649.0
Wood Residue (all)	Softwood	387	321	167	3	877
	Hardwood	267	297	93	2	660
	Total	654.0	618.0	260.0	5.0	1,537.0
All Residues	Softwood	387	629	265	3	1,283
	Hardwood	268	625	206	3	1,102
	Total	655.0	1,254.0	470.0	6.0	2,385.0

Numbers in rows and columns may not add to totals due to rounding.

Counties with less than 3 mills have been aggregated so as not to divulge individual mill level data.

Source: NREL, Virginia Forestry Department

Based on regional assets, RTI's research focused on opportunities from biomass and engineered wood products.



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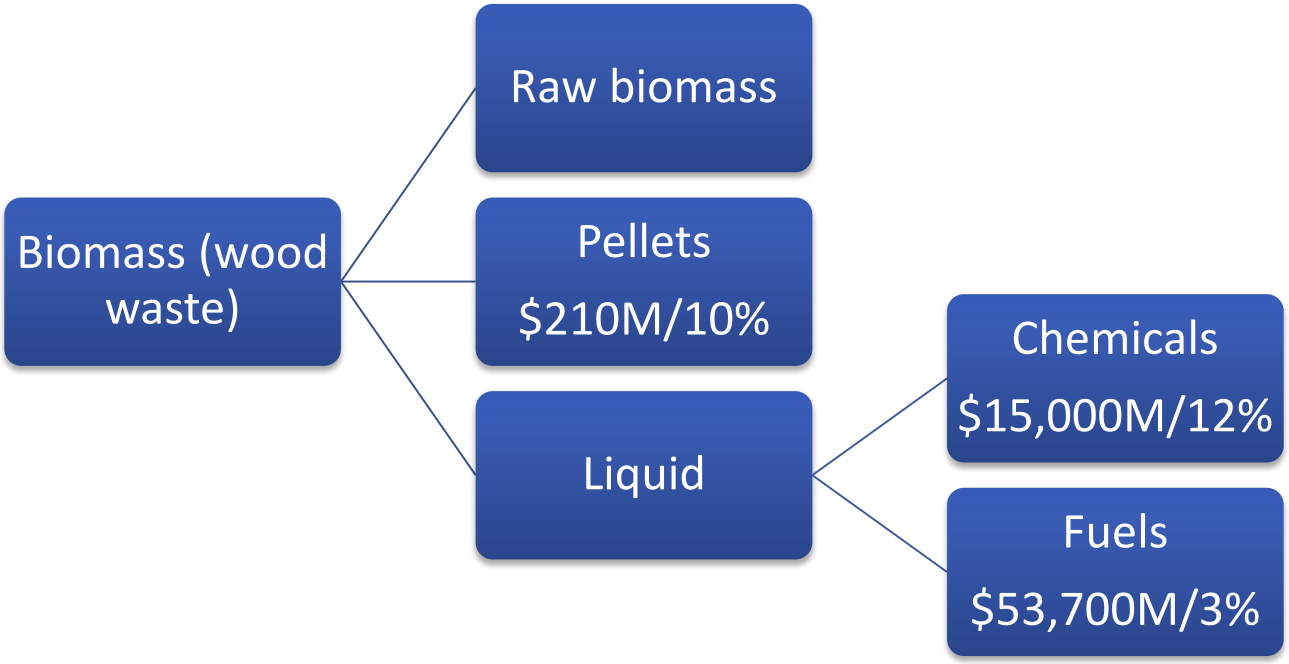
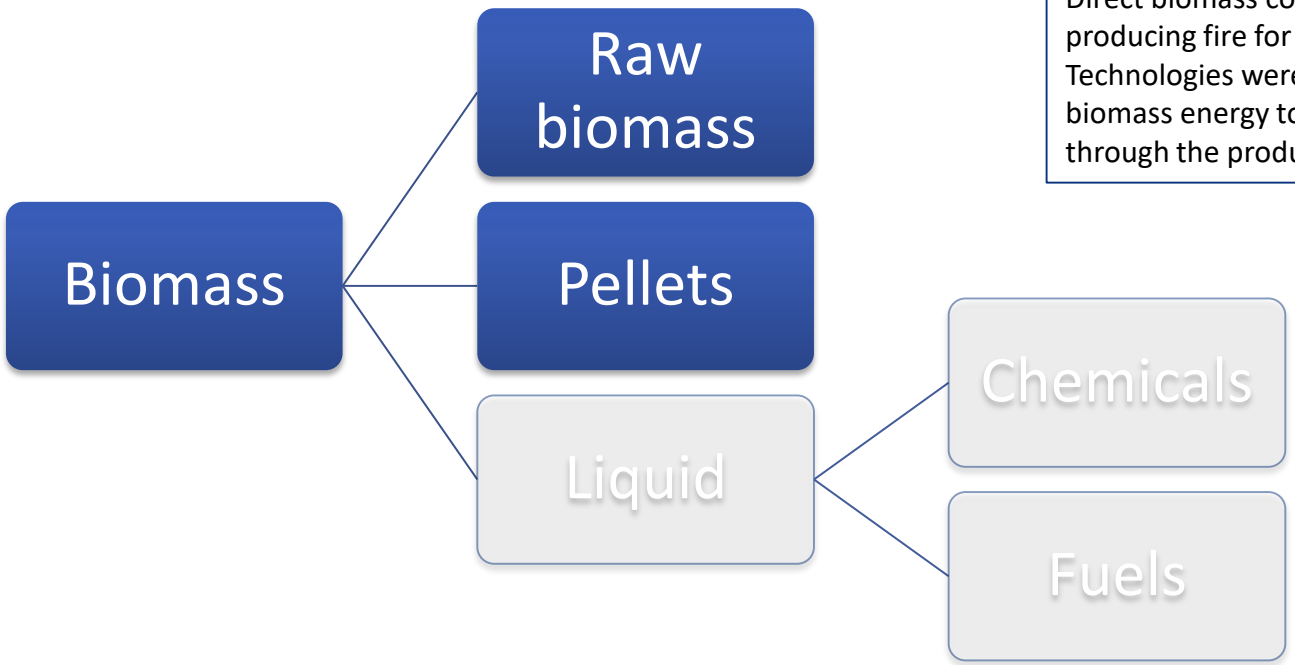
Biomass, through various conversion processes, is used for heating, electric power generation, combined heat/power, and chemicals.



Raw biomass and pellets are converted to energy through combustion.

Combustion utilizes an excess of oxidant (air) to achieve high process temperatures.

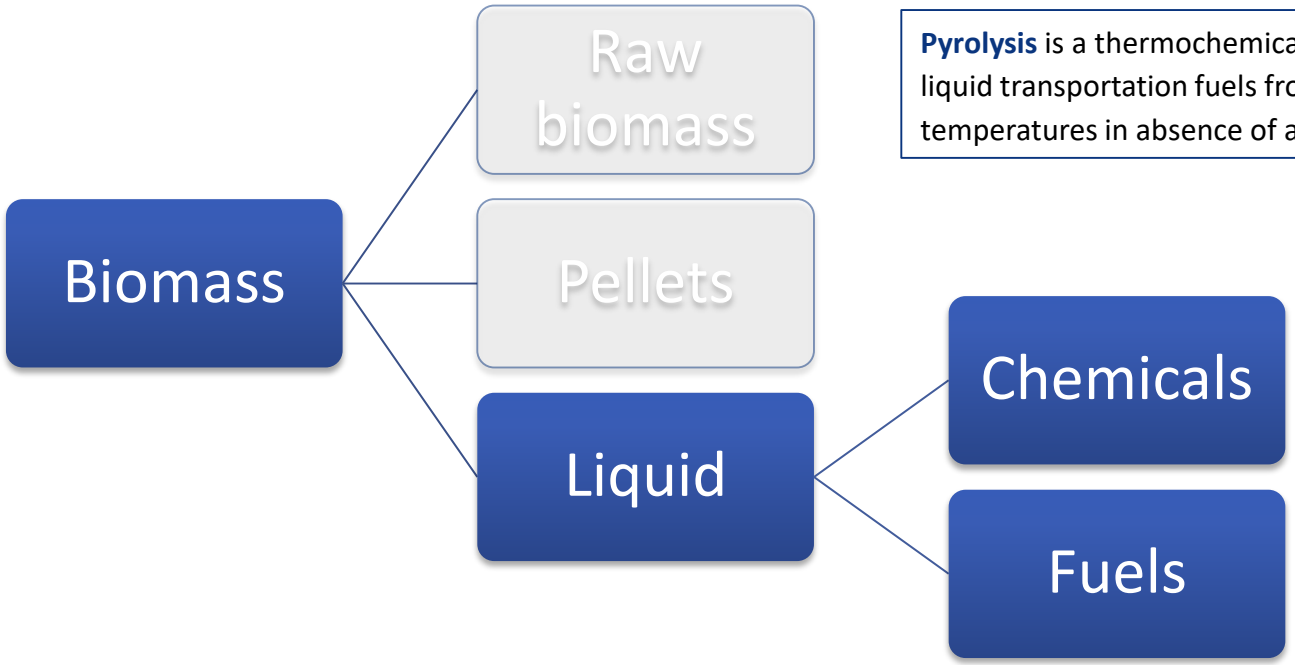
Direct biomass combustion was used for producing fire for cooking, warmth, and light. Technologies were developed to harness biomass energy to produce electric power through the production of steam.



Biomass is processed into a liquid through gasification or pyrolysis. Further conversion is required to convert biomass into a fuel.

Gasification is a thermochemical process of partial oxidation of biomass in the presence of a gasifying agent (air, oxygen, or steam). Products are known as synthesis gas or syngas.

Pyrolysis is a thermochemical processing option for producing liquid transportation fuels from biomass at modest temperatures in absence of added oxygen.



Fischer-Tropsch is a thermochemical processes that begins with the gasification to produce synthesis gas. This synthesis gas is cleaned and sent to a Fischer-Tropsch unit where it is converted to liquid hydrocarbons. Hydroprocessing refines the liquid hydrocarbons to produce jet, diesel, and naptha fuels.

Raw biomass is used to generate steam for electricity generation and to produce heat and hot water for buildings.

According to the U.S. Department of Energy, in 2017, 2% of the total U.S. annual energy consumption was from wood and wood waste such as bark, sawdust, wood chips, wood scrap, and paper mill residues.

The biomass is converted to steam and electricity, saving money by reducing the amount of other fuels and electricity that must be purchased. Some coal-burning power plants burn wood chips to reduce sulfur dioxide emissions.

Industry	Amount (trillion British thermal units)	%
Industrial	1,480	69%
Residential	334	16%
Electric power	247	12%
Commercial	84	4%

U.S. wood and wood waste energy consumption, reported by DoE

APPLICATIONS AND END USERS
(commercial/residential use and industrial use)

- In 2014, only 1.5% of electricity was generated from solid biomass within the U.S. More than half of state governments within the U.S. have incentives in place for the production of renewable energy, these do not always cover biomass, and recent growth has been much more rapid in other renewables, particularly wind and solar.

Table 1.1 Virginia Biomass Power Generation Plants

Plant	Operator	Year	Power Unit
Pittsylvania Power Station	Dominion Power	1994	83MW
Virginia City Hybrid Energy Center	Dominion Power	2012	117MW (Only 20% biomass)
Altavista Power Station	Dominion Power	2013	51MW
Hopewell Power Station	Dominion Power	2013	51MW
Southampton Power Station	Dominion Power	2013	51MW
South Boston Power Station	NOVEC/NOVI Energy	2013	49MW
Covington Power Island	WestRock	2013	75MW

Source: Virginia Department of Forestry

Biomass power generation in Virginia as of 2012

Source: EIA, Chatham House, The Economic Impact of Virginia's Agriculture and Forest Industries (2014), University of Virginia

At Longwood University in Farmville, Virginia, raw biomass (sawdust) provides heat and hot water to campus buildings.

- Sawdust from 11 local logging mills is used to produce steam that provides heat and hot water to campus buildings and is one of only two state agencies that burns biomass for heating fuel.
- A $14M new plant was constructed that contains two biomass boilers (one new; one relocated) with the option for a third boiler.
- Wood fire boilers provide roughly 80% of the campus' heat and hot water. Number two, oil, provides the additional 20% of the demand.
- The new facility includes two sawdust storage silos with a combined capacity of 18,500ft^3 (enough biomass for a week). The site also includes a sawdust handling system, pollution control devices, auxiliary equipment, administrative space, and space for additional boiler.
- There are plans to construct a processing facility 11 miles from campus. 17.68 acres will allow for a truck tipper, truck scales, and space to stockpile sawdust. Future plans also include adding a chipper to manipulate wood waste from sawmills, logging, tree trimming operations, land clearing, weather-related disasters, and municipalities.

- In 2012, combustion of sawdust saved Longwood University $4.5M, roughly 4% of the University's budget.
- Campus uses 10,000-35,000 lbs. of steam/hour
- Each boiler produces a maximum of 20,000 lbs. of steam/hour
- Utilizes 20-40 tons of sawdust/day (approx. 1-2 truckloads)
- Produces approximately 700 lbs. of ash/week

Source: Longwood University, EIA, CBS News

Through combustion, raw biomass is converted to heat and energy, but there is little value add to wood product manufactures.

Enablers	• Locally available sawdust and other waste material • Required equipment is readily available • Potential to reduce greenhouse gas emissions
Barriers	• Emission of concern from wood boilers is particulate matter (PM), although other pollutants, particularly carbon monoxide (CO), volatile organic compounds (VOC), and oxides of nitrogen (NOx) may be emitted in significant quantities when certain types of wood waste are combusted or when operating conditions are poor. Specific emissions depend on a number of variables. • Biomass power plants in commercial operation tend to be smaller (20MW) and less efficient (17-25% from steam-turbine generators) than coal or natural gas fired power plants. • Low-cost natural gas from the Marcellus region via the Atlantic Coast Pipeline will make burning wood waste for heat & power less viable.
Capital Investment	• $15M (depending on size) • Boilers, pumps, fans, storage silos
Time Frame to Adoption	• Available today
Regional Resources	• Sawdust
Risk	• The price seen for the raw biomass (sawdust) is low (excluding transportation costs)
Benefit	• Removal of wood waste from wood production site

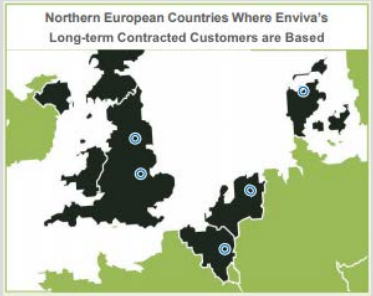
Source: EPA, Expert Interview

Wood pellets, a renewable energy source, are a growing export product, driven by European sustainability regulations.

- Wood pellet consumption in the U.S. is low and driven by:
  - Regional cost advantages vs heating oil and propane
  - Convenience vs. burning raw wood waste due to automatic feeding
  - Incentives for bio-heat targeted at the residential and commercial building sector
- industrial use of wood pellets in heat and power is not incentivized, and consumption is modest.
- Renewable Portfolio Standards (RPS) mandate the production of renewable electricity, including bio-power, but wood pellets are usually not used in bio-power facilities due to price.
- U.S. production of wood pellets is primarily for export to Europe, where it is burned in former coal-fired power plants to meet EU's 2009 Renewable Energy Directive that establishes a mandatory 20% share of renewable energy sources in the EU by 2020. Exports have grown exponentially over the past years and is concentrated in the Southeast due to low raw material and low shipping costs to Europe.
- Key players are Enviva, Drax, and Georgia Biomass. German Pellets.

APPLICATIONS AND END USERS
(commercial/residential use and industrial use)

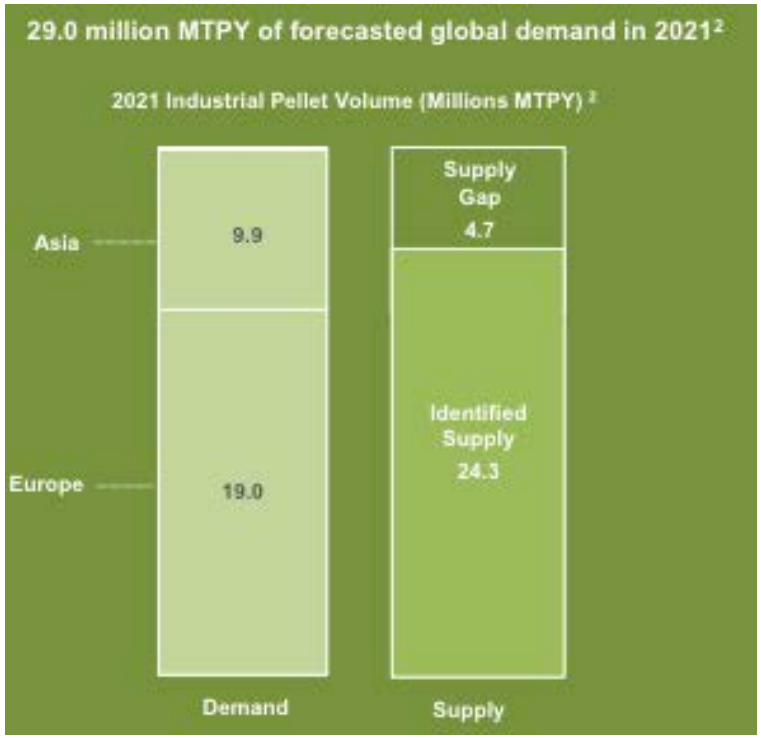
- Industrial Electricity generation: Co-fired in coal based power plant and mono-fired in converted coal power plants to reduce greenhouse gas emission of electricity generation. Moderate quality pellets.
- Residential and Commercial heating: Convenient solid biofuel application in automatic stoves and boilers. Generally higher quality pellets.
- Fuel for mid-sized heat supply systems like district heating, CHP plants; minor market share.



Source: BioMass Magazine, Enviva, BioEnergy, Global Wood Pellet Industry and Trade Study 2017

Enviva, a major supplier of wood pellets, is heavily invested in the southeast region of the U.S.

- Enviva is the only enterprise supplier of scale and noted as the largest supplier of utility-grade wood pellets to major power generators with 3 million metric tons per year of contracted production capability.
- Enviva Development Holdings, an affiliate of Enviva, develops and builds wood pellet production plants and export terminals.
- The majority of Enviva's market is in Europe, where nearly ½ of the renewable energy production is from solid biomass.
- Enviva's combined plant operations now include seven manufacturing sites in Virginia, North Carolina, South Carolina, Mississippi, and Florida, with an eighth under construction in Richmond County, North Carolina. In total, these facilities will represent more than 4 million tons per annum of production capacity consolidating Enviva's position as the world's largest wood pellet producer.

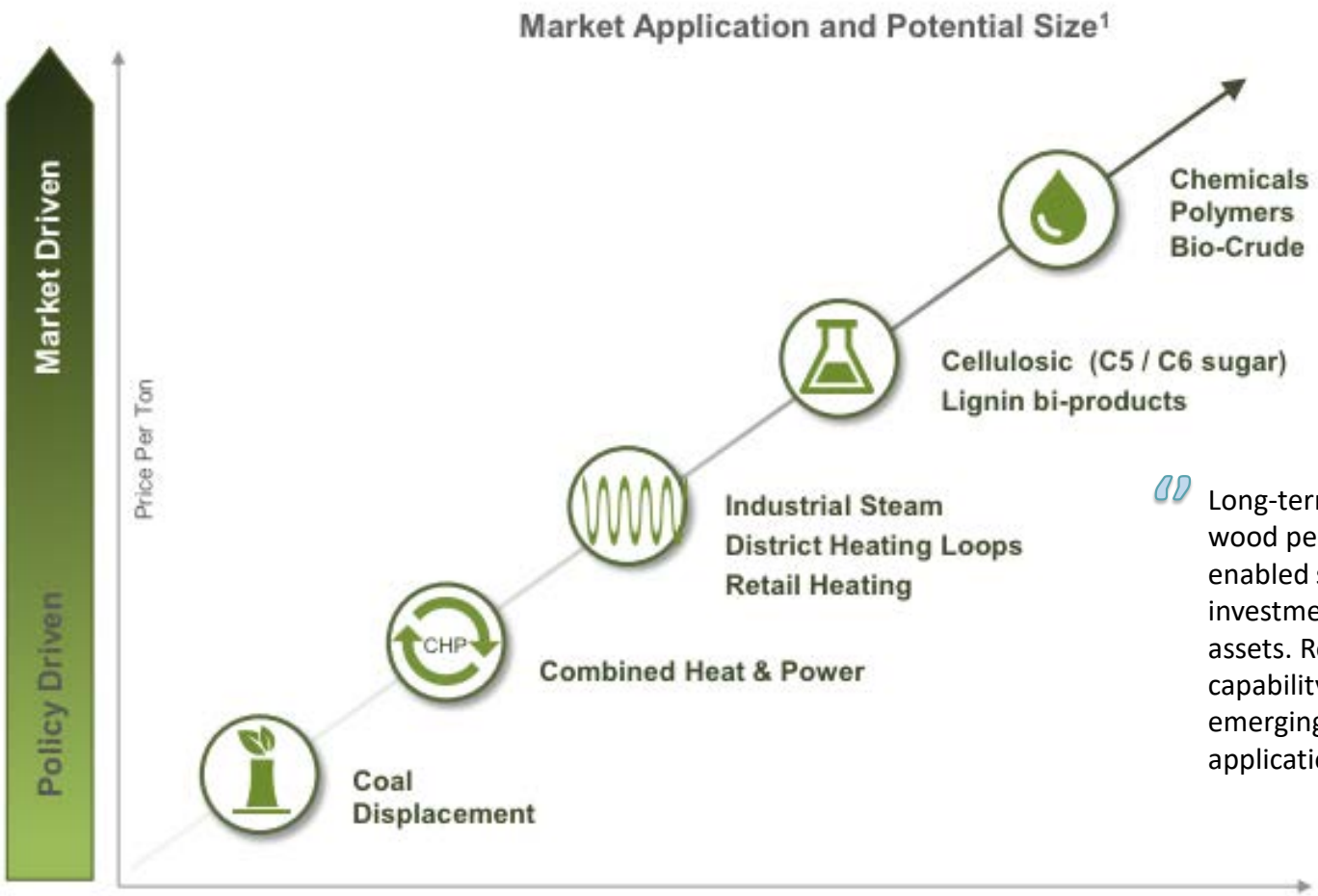


Source: BioMass Magazine, Enviva, BioEnergy, Global Wood Pellet Industry and Trade Study 2017

Enviva, a major supplier of wood pellets, is heavily invested in the southeast region of the U.S.

Source: Enviva

Wood pellets have uses beyond coal displacement and combined heat and power.



"Long-term contracted demand for wood pellet displacement of coal has enabled substantial infrastructure investment in processing and logistic assets. Resulting global distribution capability for low cost fiber can fulfill emerging demand from other applications for wood pellets"

—Enviva

Source: Enviva

The wood pellet market represents an opportunity for Region 3 to make use of its wood waste while serving expanding markets.

Enablers	• International standard ISO 17225-2 defines product requirements for moisture, energy density, abrasion resistance, partial size and shape, allowing pellets to be a commodity. • Growing global demand (6-7 Mt in 2006, 14.3Mt in 2010, and 26Mt in 2015). Europe accounts for 75% of the global demand. • Sustainable energy regulations (primarily in the EU)
Barriers	• Air quality concerns with pellets made from certain species • Transportation and/or storage costs
Capital Investment	• $125 per ton (if capacity is 100,000 tons per year, base capital cost is $12.5 M) • wood chipper, screw conveyor, magnetic separator, hammer mill, rotary dryer, pellet mill, pellet cooler, pellet packaging machine.
Time Frame to Adoption	• Some sawmills currently produce pellets and sell raw wood waste to pellet manufacturers • Potential to locate a new pellet manufacturing plant to serve export markets (2+ years)
Regional Resources	• Hardwood and softwood timber suitable for pellets. • High volume of wood waste. • Market already exists in the region.
Risk	• Relies heavily on exporting pellets • Demand in some regions is created by regulations and could be threated by changes in regulations
Benefits	• Consumes a high volume of wood waste • Potential to become a key input feedstock to bio-refineries producing advanced bio-chemicals and biofuels

Source: BioMass Magazine, Enviva, BioEnergy, Global Wood Pellet Industry and Trade Study 2017

Bio-liquids start with a variety of feedstocks to produce either a sugar or lipid intermediate that is converted to chemicals and fuel.

- Present-day chemicals and fuels are made primarily from crude oil and natural gas – finite resources that produce greenhouse gases. Scientists are researching ways to manufacture chemical products from sustainable materials.
- Virtually every petrochemical product can be produced from renewable feedstocks, including wood waste, with greatly reduced lifecycle greenhouse gas emissions.
- State-of-the-art processes were approaching cost-competitiveness with current oil-based processes before recent drops in crude oil below $50/barrel.
- Renewable chemical processes convert biomass to pure synthesis gas (syngas) which is then converted into biofuels and other chemicals using catalysts.
- Bio-chemicals/plastics are more price-competitive than fuels. Pulp and paper mills already have bio-refineries and could make conversion to chemical and fuels easier.
- According to Zion Market Research, the global renewable chemicals market is valued at **$49.22B and could reach approximately $102.76B by 2022.**
- "As of January 2018, 66 countries have established blending mandates or targets to increase renewable fuel content, a number that keeps growing every year along with the demand for biofuels in these new markets."

APPLICATIONS AND END USERS

(commercial and industrial use)

- Bio-based chemical building blocks that can replace oil-based chemicals in plastics.
- Bio-based resins that can replace fossil-based resins in plywood production.
- Bio-jet fuel for the U.S. Military and airline industry; bio-diesel fuel

Enerkem Alberta Biofuels facility

Source: Chemicals from wood waste, BioFuels Digest, Zion Market Research,

Bio-based chemicals can replace a wide range of oil-based products.

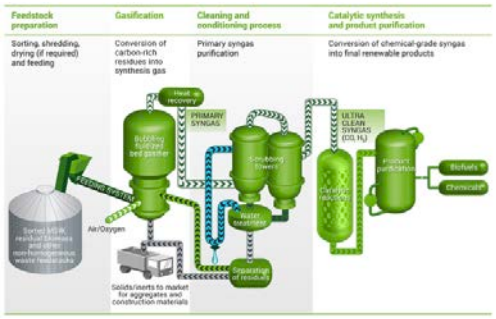
Enablers	• Pellet manufacturing, a key input to bio-based chemicals, exists in the greater region. • Corporate and government sustainability initiatives drive the market despite higher costs.
Barriers	• Technology for most products is still not proven at scale
Capital Investment	• **100M+** for full-scale bio-refinery factory
Time Frame to Adoption	• 2+ years
Regional Resources	• Wood waste (raw and pellets) • Local companies are involved (Stora Enso)
Risk	• Nascent market • Low oil prices can affect viability • Environmental permits for a new facility can be a lengthy process
Benefits	• Provides a ready market proven by regulations and corporate/industry goals • Reduced environmental impact • Incremental step to other biofuel alternatives

Source: Chemicals from wood waste, BioFuels Digest, Zion Market Research Expert Interviews,

Biofuels are created through gasification or digestion, dependent on available quantities of waste. Partners exist depending on process.

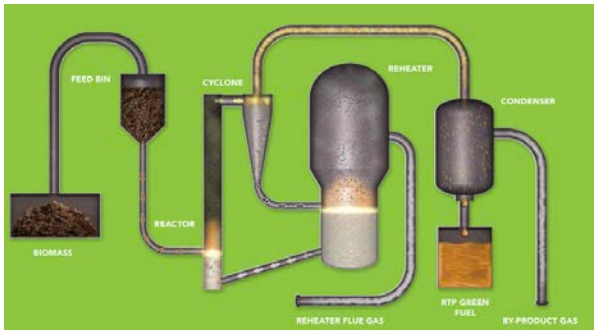
GASIFICATION: ENERKEM

- Facility in Alberta is the first-ever waste-to-biofuel facility to sell its ethanol under the U.S. Renewable Fuel Standard (approval from EPA in 2017).
- $120 million facility in Edmonton, Canada generates $65 million per year in net economic benefits in the community, according to Enerkem.
- Allows partners to implement production through license of exclusive technology. Each facility is advertised to create 610 direct and indirect jobs.
- End products are methanol and ethanol.



PYROLYSIS: ENVERGENT (HONEYWELL)

- Uses a rapid thermal processing technology (RTP), a fast thermal conversation process used to convert cellulosic biomass feedstock (forestry or agricultural residuals) into fuel for heating, power, and transportation.
- RTP technology also produces char and a non-condensable gas, both of which can be used to provide process energy in the reheater to maintain the RTP process and/or in the dryer to condition the biomass making the RTP process self-sustaining.
- Notes that hardwoods are excellent, yields are 70-75% weight, 17.2-19.1



FISHER-TROPSCH GASIFICATION : RED ROCKS BIOFUELS

- Produces a drop-in, renewable, low-carbon jet/diesel fuel from proprietary integration of existing technologies to enhance the established Fischer-Tropsch process.
- RRB will build a global portfolio of refineries to convert waste wood into renewable jet and diesel fuels to help civil and military aviation meet their CORSIA commitment goals to reduce greenhouse gas emissions.
- Plant approved for construction in Lake View, Oregon in April 2018 (under review since 2013) and expected to convert 136,000 tons of wood biomass into 15 million gallons of renewable fuel annual. Deliveries are expected to begin by December 2019.

"Red Rock will help us make our environmental goals as we have a continuous eye to reduce our carbon footprint. This facility is key to our strategy." **Michael AuBuchon, fuel supply chain Director, Southwest Airlines**

Source: Red Rocks, Envergent, Enerkem, Expert Interviews

Converting wood waste to bio-fuel could bring value to the region once proven at scale.

Enablers	• Renewable Fuel Standards • Commitments from the U.S. military and commercial airlines to purchase renewable jet fuel.
Barriers	• Economic viability is tied to the price of oil, which fluctuates. • Technology is not yet proven at scale.
Capital Investment	• **$120M+** • Full facility
Time Frame to Adoption	• 5+ years
Regional Resources	• Wood waste • Natural gas pipeline runs through region • Colonial and Plantation pipelines run through region
Risk	• Reduction in oil price can affect viability. • Environmental permits for a new facility can be a lengthy process.
Benefit	• Potential to utilize high volumes of wood waste • Capture greater value from wood waste

Source: Red Rocks, Envergent, Enerkem, Expert Interviews

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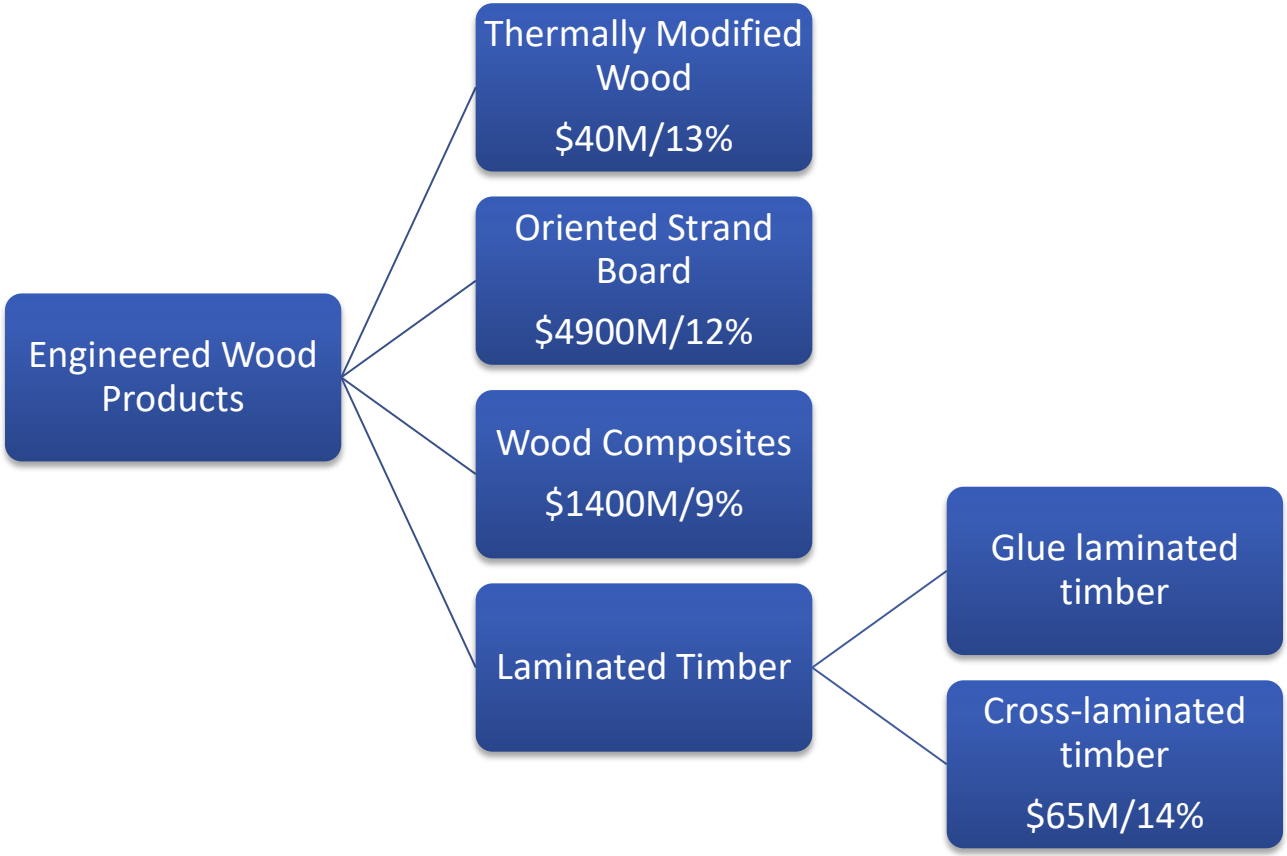
Global sustainability concerns are expected to drive market growth in engineered wood products.



RTI INTERNATIONAL GENEDGE

Engineered wood products offer potential for regional growth by leveraging regional assets and adding value to lower-value hardwoods and wood waste.

Cross-Laminated Timber (CLT)

- Global CLT market was valued at $558.6M in 2016 and expected to be valued at $2.07B by 2025 (CAGR of 15.7%).
- North America market was valued at $65M in 2016.
- Soft and lower valued hardwoods for walls, roofs, and floors.
- Strength in two directions.

Glued Laminated Timber (GLULAM)

- The global GLULAM market is anticipated to reach $8.0B by 2025.
- Soft and lower valued hardwoods for structural beams with standards for both.
- Strength in one direction.

Oriented Strand Board (OSB)

- $5B market within the U.S.
- Forecasted compounded annual growth rate of 8.3%
- Cross oriented rectangular wood strands for subflooring, wall and roof sheathing, structural insulated panels, industrial containers and furniture.
- Light weight and easy to handle relative to strength

Thermally Modified Wood (TMW)

- Global market $400 million; 18% CAGR
  - Europe accounts for >80%
  - U.S. market is nascent (<10%)
- Converts low-value softwood and hardwood to high-value products for outdoor decking, siding, flooring and windows.
- Environmentally sustainable

Wood Composites

- Global wood plastic composite market is expected to reach $9.77B by 2024 with composite decking & railing to be worth $3.09B by 2020.
- In 2015, North America accounted for 45% of the global market volume.
- Sawdust and resin for decking, fencing, and siding.
- Durable with little long term maintenance

Source: GrandView CLT, Report Linker GLULAM, GrandView OSB, Grandview Composite Woods

RTI focused on CLT, TMW, and OSB because they offer the best growth opportunities.

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Not a deep focus because the same plant could make GLULAM.

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- [illegible] resin for decking, fencing, and si[illegible]
- Durable with little long term maintenance

Did not focus because the region would only supply sawdust (low value), and a strong competitor already exists in the state.

Source: GrandView CLT, Report Linker GLULAM, GrandView OSB, Grandview Composite Woods

Cross-laminated timber (CLT) production and use has been concentrated in Europe, but demand is increasing in the U.S.

CLTs are planks of timber glued and oriented at 90 degrees to each other, bonded together, and pressed to form a solid. Panels can be as large as 10’ wide and 40’ long. Pieces are shipped to construction sites and can be assembled by just a few workers. Panels are cut to size, including cutting holes for doors, windows, and electrical with computer numerical controlled (CNC) routers.

CLTs are a carbon negative material. Using CLTs could reduce construction costs by up to 50% and increase speed of construction as much as 65% because CLT is a lighter material (requires smaller and less expensive building foundations). Panels can be quickly and efficiently assembled onsite, reducing construction cost, labor and the amount of trucks, noise, and neighborhood disruption. Hardwood CLTs can take low-grade, ow-value hardwoods and turn them into high-value CLT construction.

In 2016, the global CLT market was valued at $558.6M and is expected to be worth $2.07B by 2025. The nascent North America market was valued at $65M in 2016. The overall CAGR for CLTs is 15.7% from 2017-2025, resulting in an expected U.S. market value of $241M in 2025.

APPLICATIONS AND END USERS

(commercial/residential use)

Long spans for walls, floors, and roofs within building construction.

International Beams is opening the first CLT plant in the south east in September 2018. The $19.6M investment will create 60 jobs at the plant and will create other jobs in local timber, sawmill, and trucking likely leading to 200 new jobs total. The company will use southern pine lumber to construct the panels.

Source: Woodworking Network, PalletEnterprise, BioProducts Business, APA, Expert Interviews

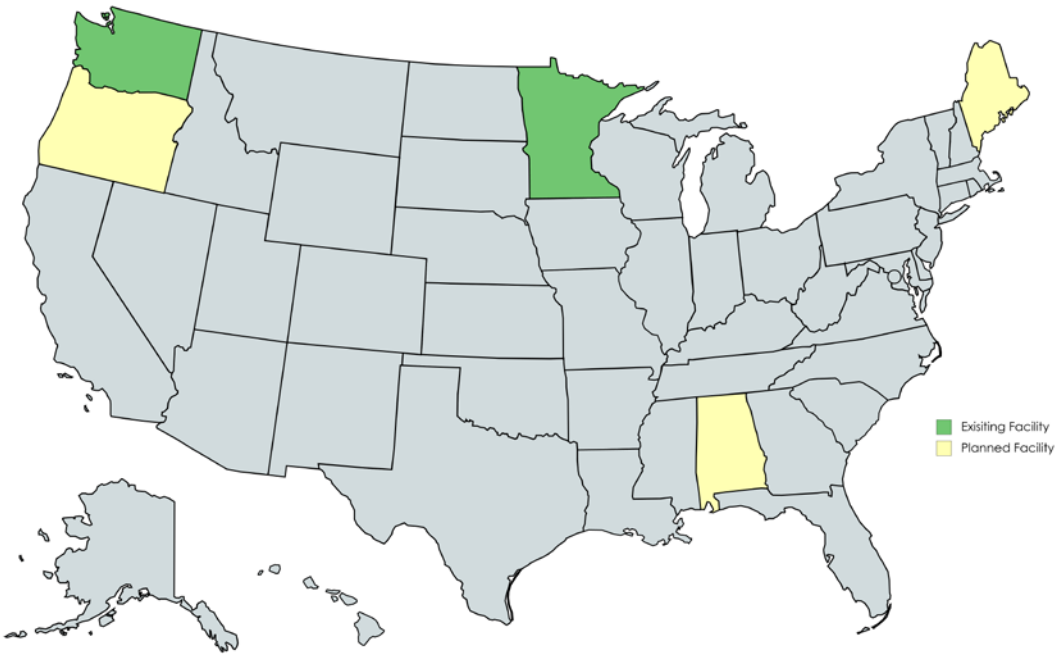
Six CLT manufacturing sites will be operational in the next few years.

The U.S. has two CLT plants and plans for four additional plants. Current plants are operated by SMARTLAM (Montana) and DR Johnson (Oregon) and both manufacture softwood CLTs.

- International Beam is opening a plant in Alabama.
- Katerra is opening a plant in Washington State and Maine.
- SmartLam is opening a plant in Maine.

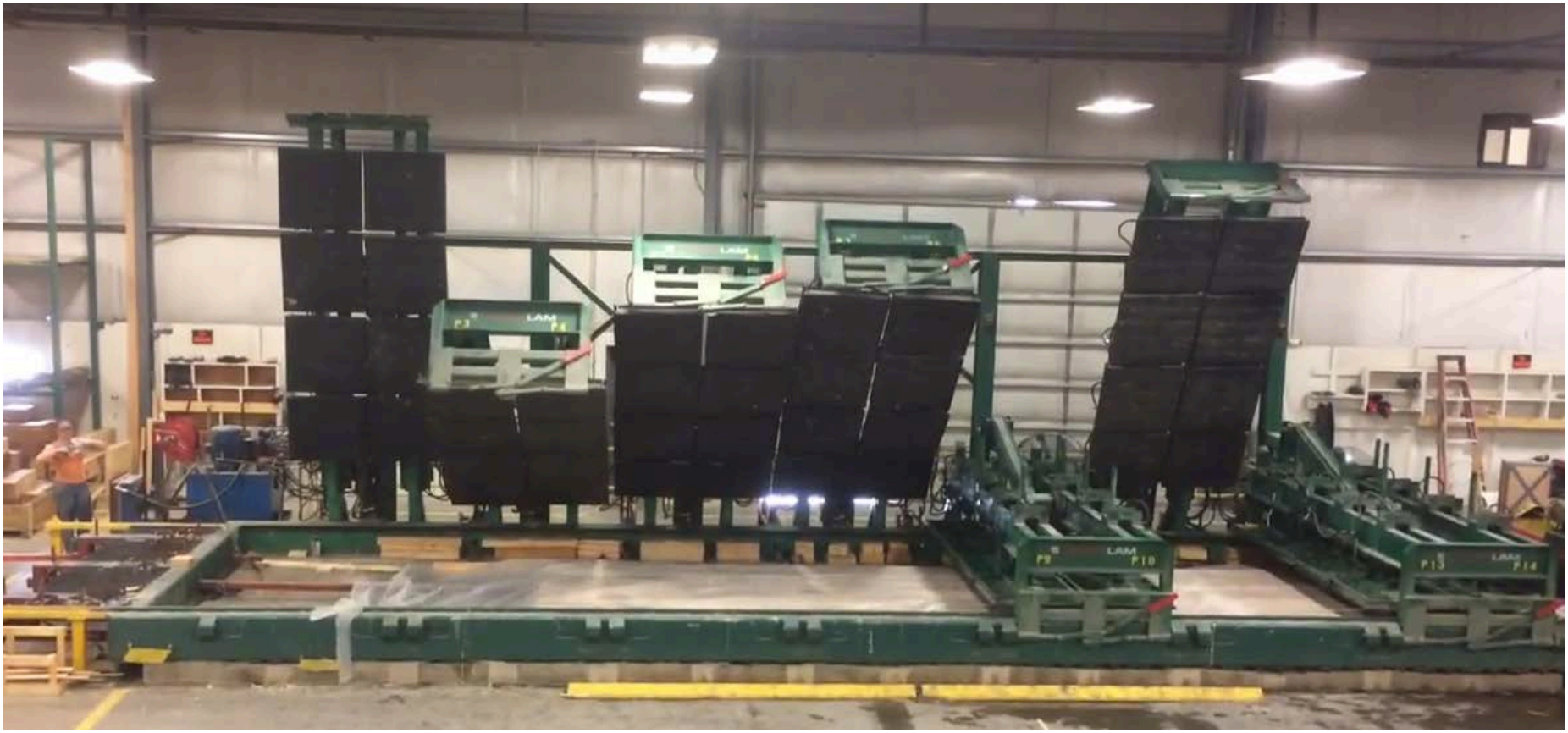
Expert interviews suggested that new entrants consider making a CLT out of yellow pine with a hardwood veneer on top. This is less expensive while providing the desired look of hardwood.

Experts at Virginia Tech recommend engaging European CLT leaders when seeking out partners. European companies have mature methods and may be interested in tapping into the new and growing U.S. market.



Current and future CLT manufacturing sites within the U.S.

The U.S. Forest Service awarded Boston based architectural firm, IKD, $250,000 to fund the construction of the first hardwood CLT project in the U.S.



Architects and engineers want to use hardwood CLTs in building designs; however, cost may make the wood industry hesitant.

Enabler	• Increased global demand for CLTs. Interviewees noted that the U.S. could have sufficient demand to warrant a new plant. • Greenhouse gas reduction regulations and incentives (e.g., LEED credits)
Barriers	• Lack of standards for hardwood CLTs (Standard for softwood is ANSI/APA PRG 320-2018). • Does hardwood CLTs make economic sense-lack of a strong business case? • Concern with glue adhesion when manufacturing with hardwoods • Concerns of fire, decay, and earthquake resistance, although not based in fact • Vertical integration with lumber suppliers and glulam producers is likely a key for success
Capital Investment	• A 50,000 m3/year capacity CLT plant requires **$10-15M USD investment** • Sophisticated machinery to inspect dimensions, defects and moisture content of lumber, finger jointing equipment, large presses to form panels, CNC machines, large material handling capabilities.
Time Frame to Adoption	• 2-3 years (time to build a new facility)
Regional Resources	• Soft and hardwoods (sycamore, sweet gum, tulip, and other lower price point hardwoods)
Risk	• Only four companies in the world make the sandwiching machine needed for CLTs. • Four additional CLTs plants are already planned for the U.S. • The amount of raw material required to produce 50,000 m3/year of CLT panels is equivalent to 25 million board feet (at 80% yield).
Benefit	• Building material with almost no carbon footprint

Source: Woodworking Network, PalletEnterprise, BioProducts Business, Expert Interviews

Thermal modification is a chemical-free treatment that results in enhanced resistance to decay and improved dimensional stability.

- In the thermal modification process, the wood is heated to temperatures much higher than transitional wood drying and sometimes in absence of oxygen for a short period of time, altering the chemical composition of wood by degrading cell wall compounds.
- TMW processing reduces the moisture content to 4-6%, permanently changing TMW's ability to react to humidity as quickly as an untreated timber. Benefits include improved durability, resistance to pests, and dimensional stability. TMW looks and performs similar to exotic hardwoods.
- TMW has been used within Europe for decades. Commercial kilns were first introduced in North America in the mid 2000s to enhance durability and value of some hardwoods.
- American Hardwood Export Council believes that the American tulipwood has a "particularly bright future for cladding. It treats and machines easily and is light-weight, competitively priced and readily available."

APPLICATIONS AND END USERS

(commercial/residential use)

Outdoor furniture, windows, decking, siding, flooring, specialty wood products.

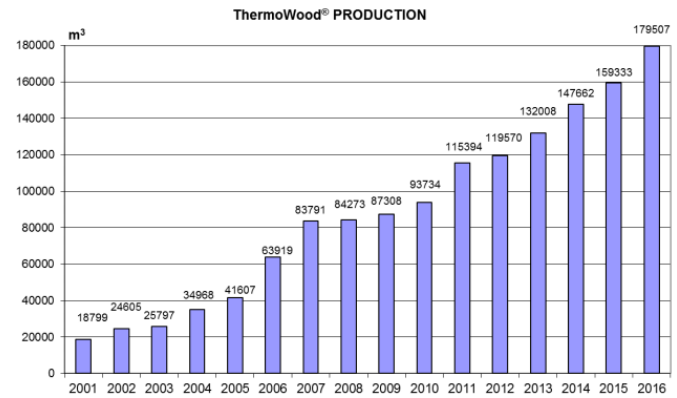
Product	Durability	Stability	"Green"	Appearance	Price	Total
Pressure-treated softwood	●●	○○○	○○○	○○○	●●●	-4
Cedar	●	○○	●●●	○	●	0
Tropical wood	●●	○○	●●●	●●	○	+4
Composite wood	●●	●●●	●	○	●●	+7
Thermo-treated Product	●●●	●●●	●●●	●●●	●●	+14

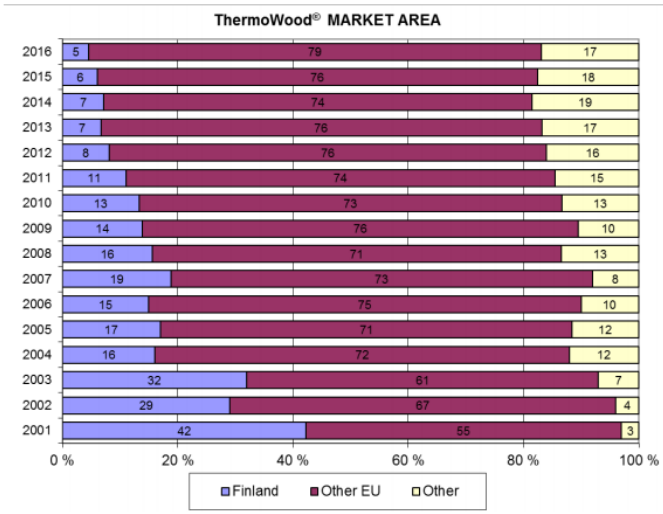
Reported by WestWood

Source: AHEC, University of Minnesota, WestWood Timber, International ThermoWood Association, Marketing Strategy Recommendation for TMW (University of Minnesota), Hardwood Distributors, Expert Interviews

In Europe, where TMW was developed, the market is established but still growing rapidly.

- The global market for TMW is approximately $400 million.
- The European market accounts for 80 percent of the global market and is still growing at >20-25% per year for the last 5-6 years.
- The U.S. market is nascent and regional, including importers of European products and several U.S. manufacturers.
- The American Hardwoods Export Council is actively promoting the use of American hardwoods for thermal modification in Europe.
- Meanwhile, marketing in the U.S. market is fragmented, without a similar degree of industrywide promotion as Europe enjoys.



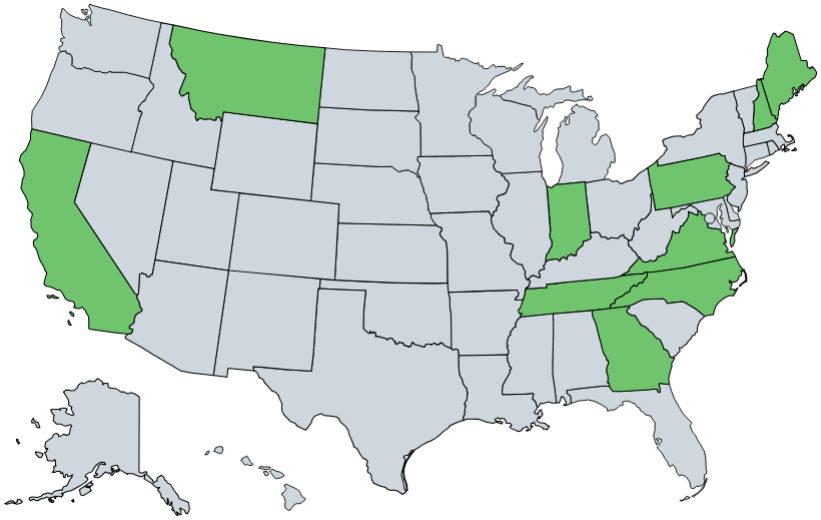


Source: AHEC, University of Minnesota, WestWood Timber, International ThermoWood Association, Marketing Strategy Recommendation for TMW (University of Minnesota), Hardwood Distributors, Expert Interviews

TMW is manufactured in only a few states within the U.S.

100+ facilities worldwide produce commercial quantities of TMW. The main sites are in Europe and ~ 10 companies within the U.S.:

- EcoVantage (IN)
- Bailey Wood Products (PA)
- Arbor Wood Co (MN)
- Pakari (CA)
- Superior ThermoWood (MN)
- Hot Woods (MT/MA) *smaller production
- Thermo Treated Wood (GA)
- Atlanta Harwood Corporation (TN, GA, NC, PA)
- Bingaman & Son (PA)
- **Northland Forest Products** (NH, **VA**)



Thermally Modified Wood Manufacturers within the U.S.

Distributors:

- *Thermory USA (CA, importer), Cambia Wood (NH), Ceder Creek (MN)*

Source: AHEC, University of Minnesota, WestWood Timber, International ThermoWood Association, Marketing Strategy Recommendation for TMW (University of Minnesota), Hardwood Distributors, Expert Interviews

Although the market for TMW is nascent within the U.S., experts report an increase in demand for TMW.

Enablers	• Pilot plant in Minnesota serves as a test bed. Architects are reportedly driving demand (market pull rather than push). • Virginia Tech is applying for a grant that will analyze the TMW market. • Achieved technical maturity and commercial success in Europe • Existing equipment manufacturers in Europe
Barriers	• Lack of sales channel (early stages of market development with just a few producers and distributors within U.S.). • Unfamiliarity with TMW within the U.S.; mixed perceptions about its performance as decking material.
Capital Investment	• $.75M-$1M for a lower volume solution and **$2-$3M for a higher volume solution**
Time Frame to Adoption	• Presently available
Regional Resources	• Soft and hardwoods (sycamore, sweet gum, tulip and other lower price point hardwoods) • Wood waste can be used to fire the kiln
Risk	• Processing is different depending on equipment, species, desired product performance properties. • Bending strength is slightly reduced, leading to questions on use of TMW for certain structural applications.
Benefits	• Emerging, chemical-free technology produces sustainable, value-added wood products with improved dimensional stability, resistance to biodegradation and weathering, extended service-life, and reduced environmental impacts. • TMW processing can nearly double the value of lumber

Source: AHEC, University of Minnesota, WestWood Timber, International ThermoWood Association, Marketing Strategy Recommendation for TMW (University of Minnesota), Hardwood Distributors, Expert Interviews

Oriented strand board is made by blending rectangular wood strands with thermosetting water-resistant adhesives and wax.

Oriented strand board (OSB) is an engineered wood that is strong, uniform, dense and workable. It is make from wood strands and adhesives that are compressed together – similar to plywood.

The U.S. oriented strand board market is estimated to be $5B USD with a forecasted compounded annual growth rate of 8.3% through 2025.

Benefits includes high strength to weight ratio, easy of installation, and the ability to use for structural and non-structural applications.

Key U.S. players are: **Huber**, Norbord, Louisiana-Pacific, ARBEC, **Georgia-Pacific**, **Weyerhaeuser** and RoyOMartin.

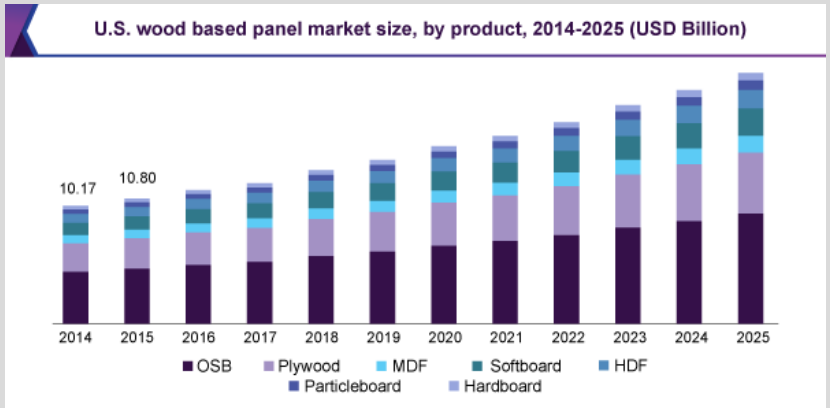
In 2013, Georgia-Pacific opened new plant in Clarendon for the manufacturing of different OSB products such as Thermostat OSB Radiant Barrier Sheathing.

Louisiana-Pacific recently advertised a fire-rated OSB sheathing

APPLICATIONS AND END USERS

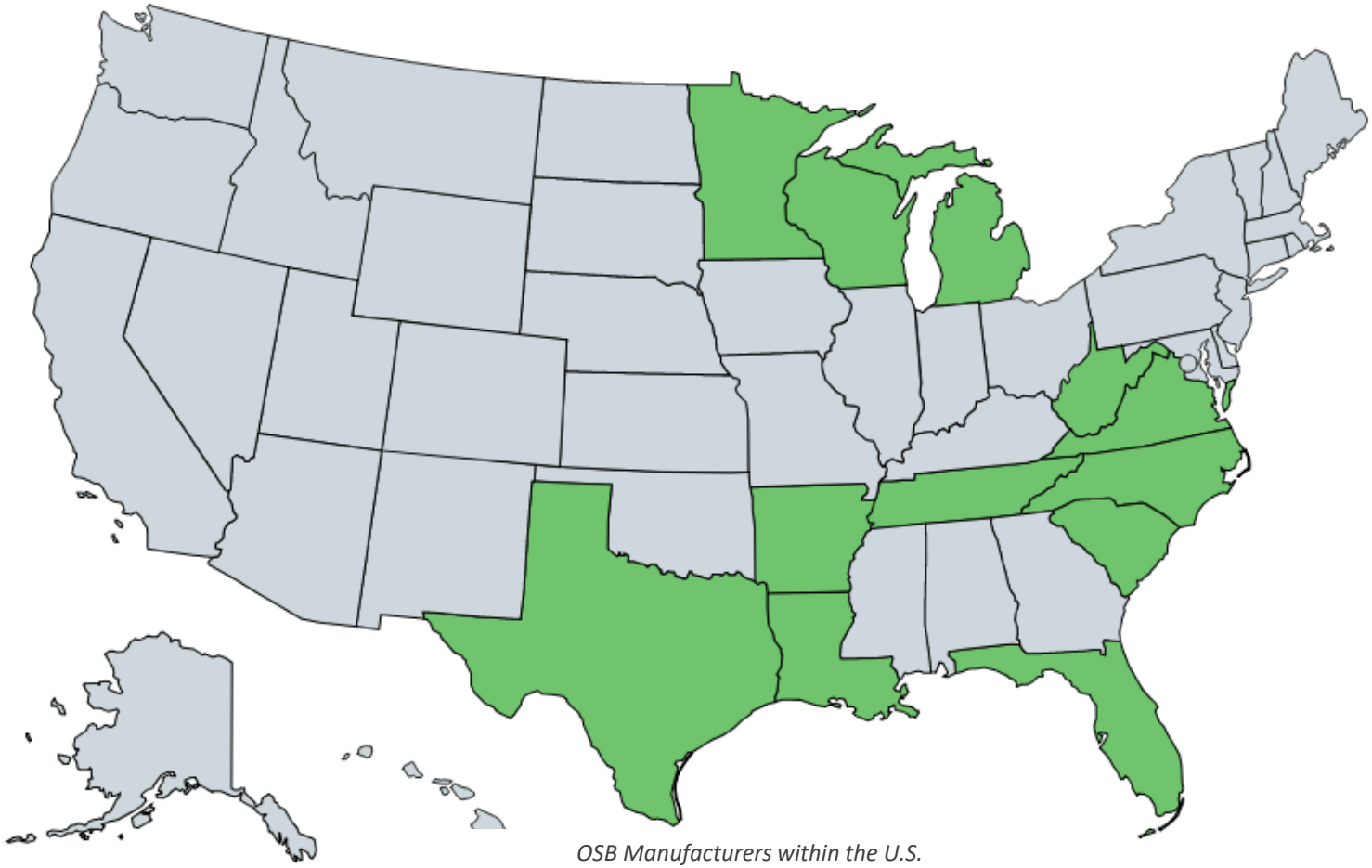
(commercial/residential use)

Subfloor, wall, and roof as well as shelving, pallet manufacture, frames, furniture, dry storage pallets, and packaging.



Source: GrandView, AIA, APA, Woodworking Network

Oriented Strand Board is manufactured throughout the southeast of the U.S.



OSB Manufacturers within the U.S.

OSB is an engineered wood panel that shares many of the strength and performance characteristics of plywood.

Enablers	• Ability to manufacture in 9 foot lengths, up to 16 feet while plywood is generally limited to 8-10 foot lengths. • Typically at a lower price point than plywood • Light weight while high strength and easy to install.
Barriers	• Perception that OSB is not fire retardant • Perception that OSB has moisture problems that could lead to swollen edges
Capital Investment	• **$280M (Greenfield facility, 158 acres)**
Time Frame to Adoption	• Presently available
Regional Resources	• Rectangular wood strips from hard or softwoods
Risk	• OSB weighs about 2 pounds more per sheet, increase in transportation cost • OSB takes longer to dry out when exposed to moisture compared to plywood
Reward	• Market growth due to high strength to weight ratio and easy of installation.

Source: GrandView, AIA, APA, Woodworking Network

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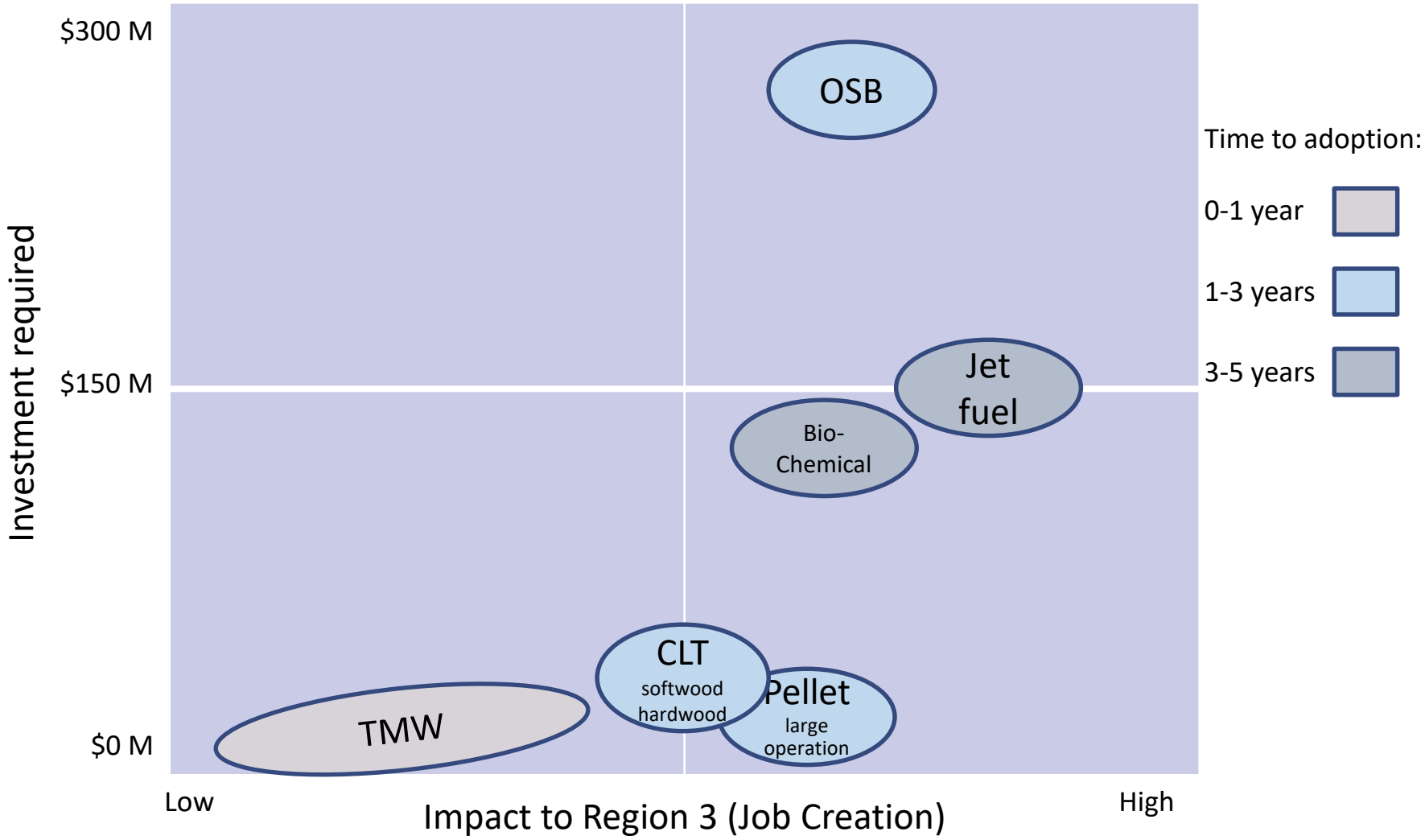
Recommendations: Analysis of Opportunities

PORTFOLIO ANALYSIS



Engage industry leaders and experts in the identified markets to vet opportunities, explore partnerships and inform growth strategy.

Pellets

- Pursue supplying pellets to European market and opportunities for pellets within chemicals.
  - Enviva (active in the southeast).
  - Stora Enso, etc for use of pellets within bio chemicals (Danville).

TMW

- Consider a regional market development program.
- Assist a local sawmill in purchasing a wood waste fired kiln.
- Consult with experts at UMN, VATech and AHEC to select equipment and design market development program.
- Promote within the region for new construction (training on how to work with TMW).
- Explore partnerships with home builders and architects.

CLT

- Continue talks with U.S. CLT manufacturers about interest for opening a plant in Virginia.
- Experts at VATech recommend engaging European CLT leaders who have mature methods and may be interested in tapping into the new U.S. market.
- Consider softwood as the entry point with movement into hardwood as standards are created.

Liquids

- Monitor key players within biofuel development.
- Monitor Stora Enso, etc, lignin-based chemical market development for expansion opportunities.

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September 2018

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