

Photo Credit: Oregon Forest Products Institute



Photo Credit: D. R. Johnson



**Brian Brashaw, Program Manager**

**US Forest Service, Forest Products Laboratory**

**CHANGING MARKETS IN THE WOOD INDUSTRY**  
**13<sup>TH</sup> ANNUAL SUSTAINABILITY CONFERENCE**



# My Forest Products Story...

*As a youth growing up in the Nicolet National Forest, I understood the connection between the forest and Connor Forest Products where my Dad worked. Despite moving from Laona in 5<sup>th</sup> grade, I accomplished my youth goal of being a forester with a career in forest products. After 25 years as a wood specialist in Minnesota, I joined the Forest Service's FPL in 2015 to fulfill a career goal and work to strengthen the connection between our forests, research, and markets. I am proud to work alongside my Forest Service colleagues and partners to support resilient forests and communities.*

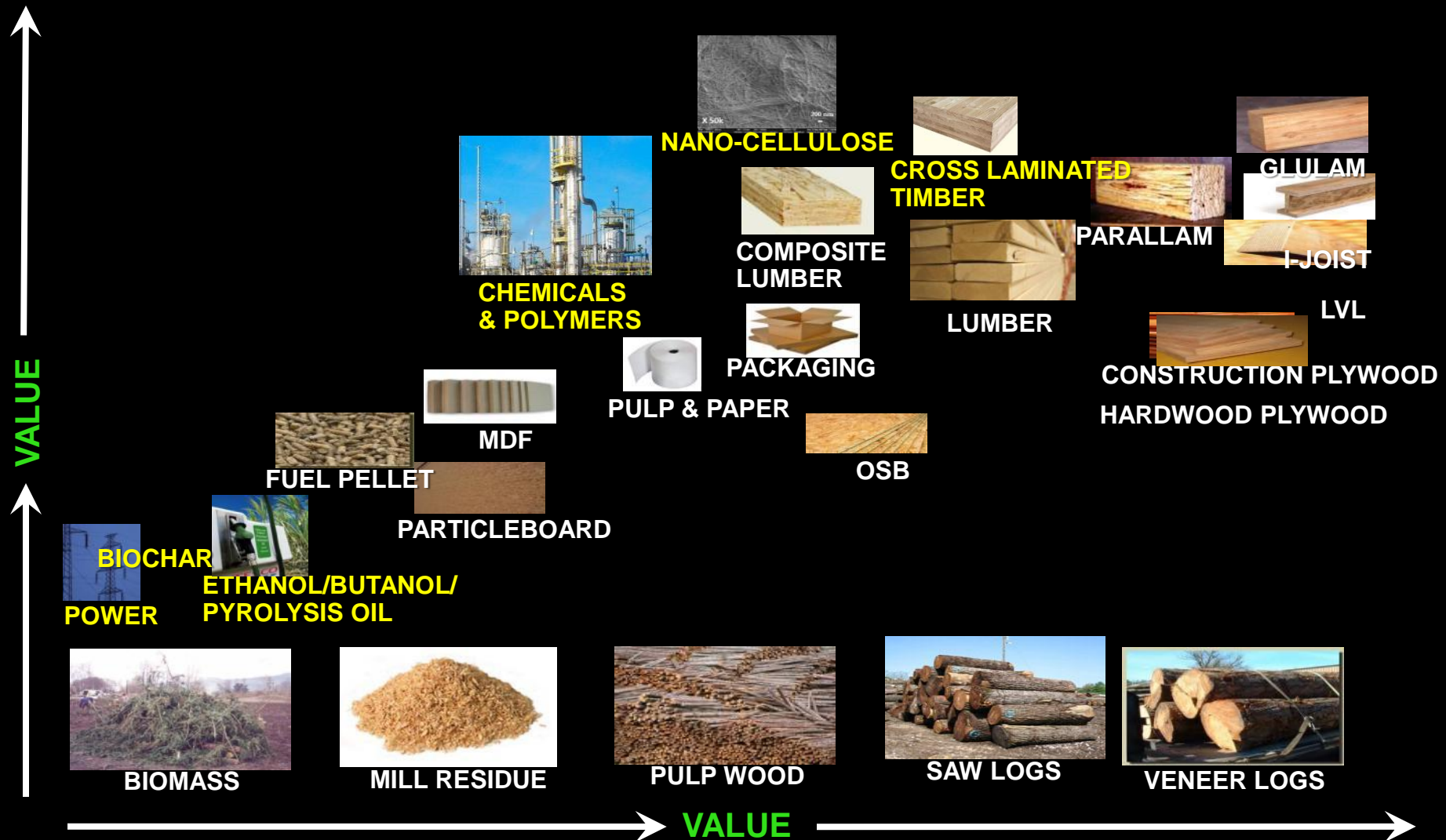




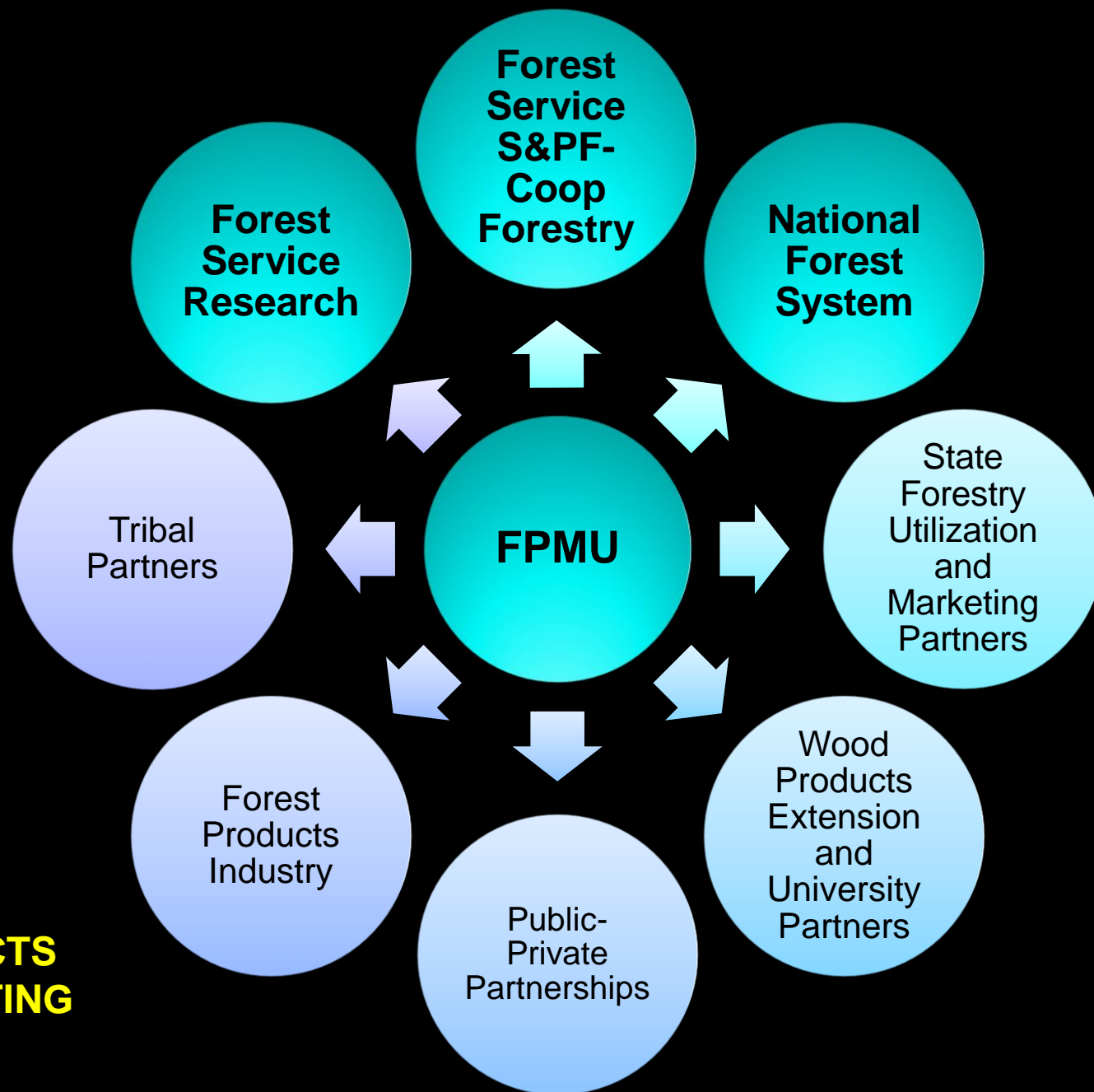
# **USDA Forest Service Forest Products Laboratory**

- **Established 1910**
- **150 Permanent Employees (50 Scientists)**
- **FY16 Federal Funding \$26.6 million**
- **150 Cooperative R&D agreements**
- **Program Leverage \$4 - \$5 million**

***A key element in maintaining healthy, resilient forests is our ability to provide value-added products from the full complement of forest biomass.***







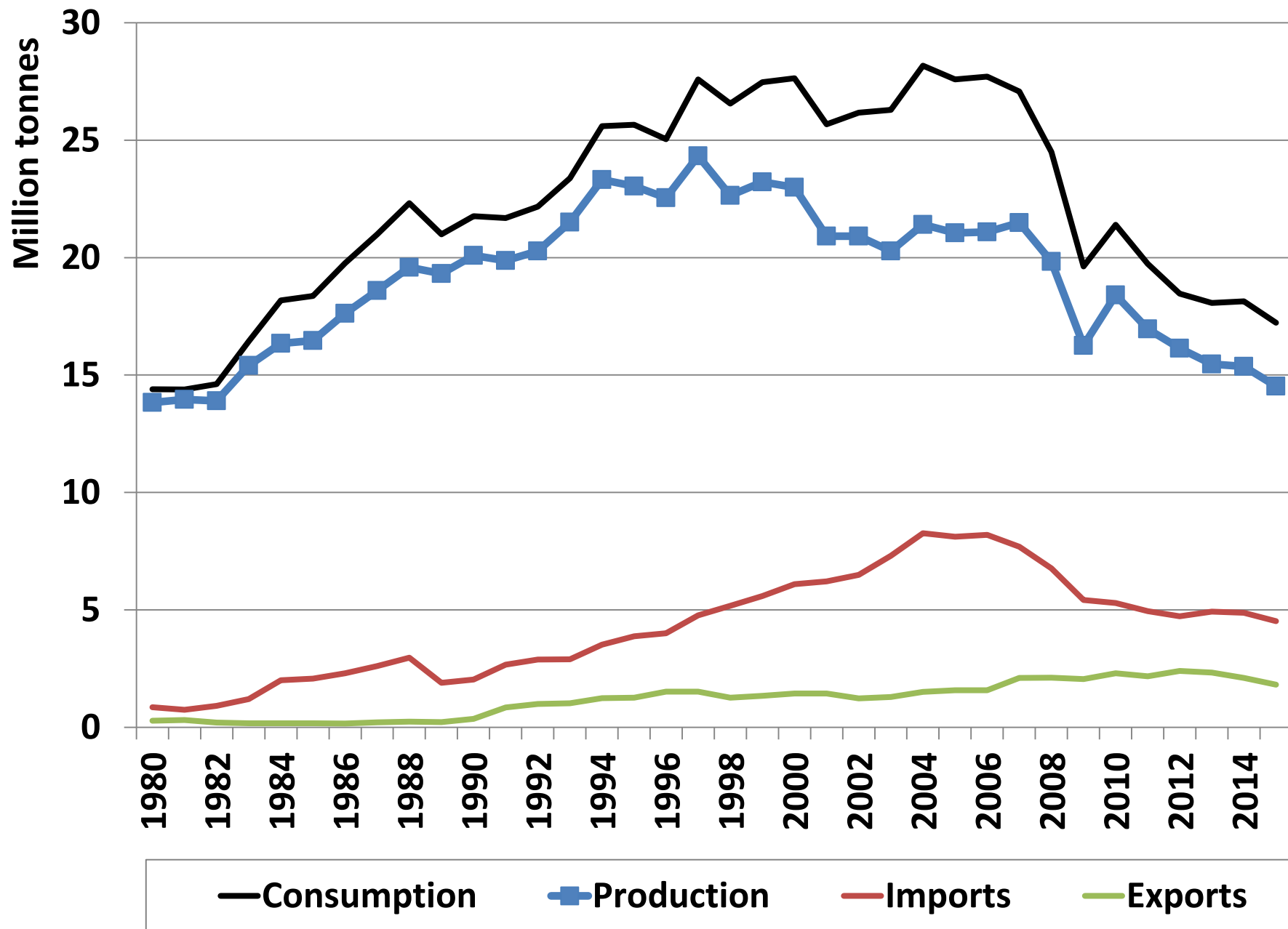
**FOREST  
PRODUCTS  
MARKETING  
UNIT**



**MARKETS**

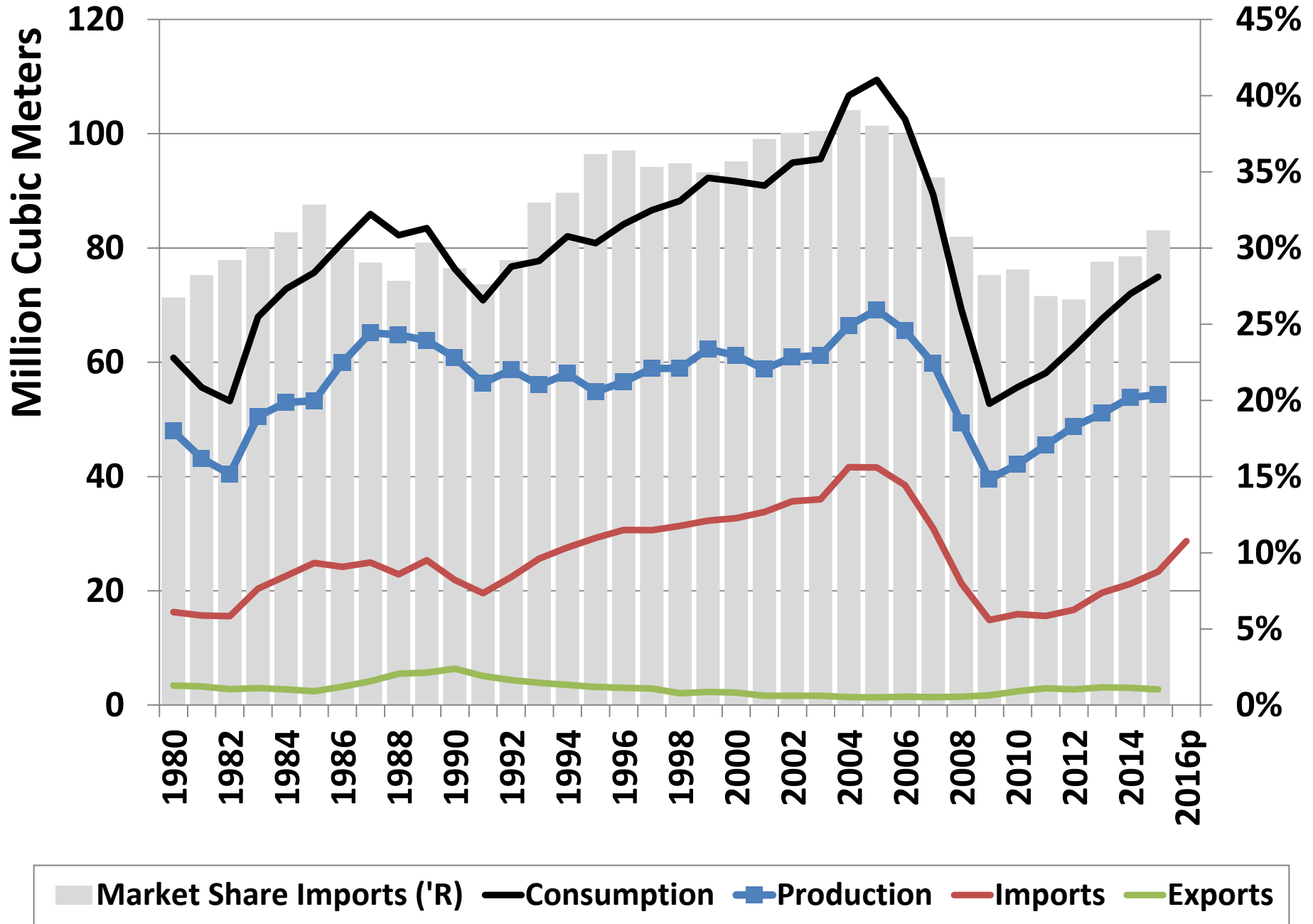
# U.S. Printing-Writing Papers Stats

Courtesy: D. Deckard 2017



# U.S. Softwood Lumber Stats

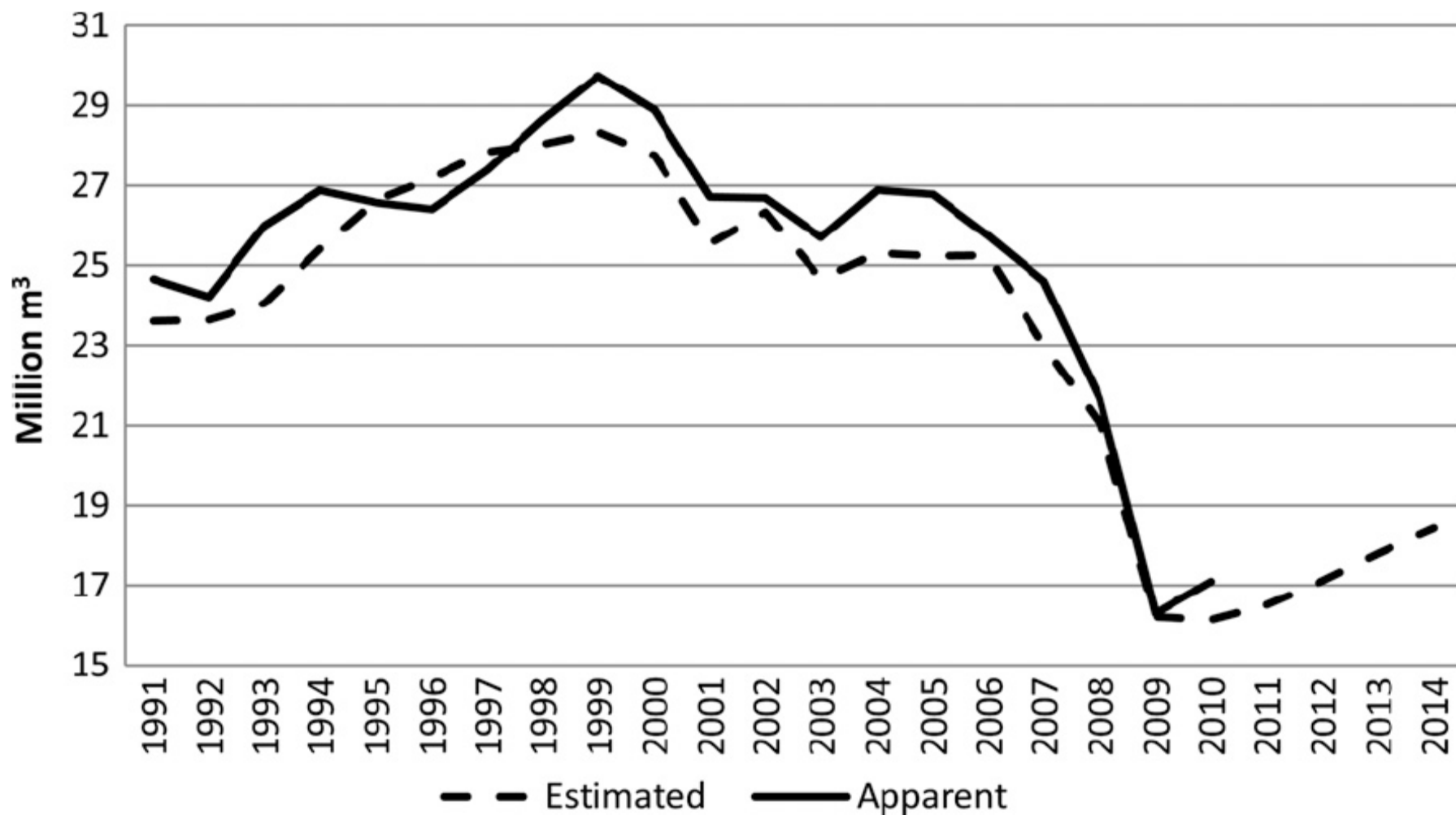
Courtesy: D. Deckard 2017



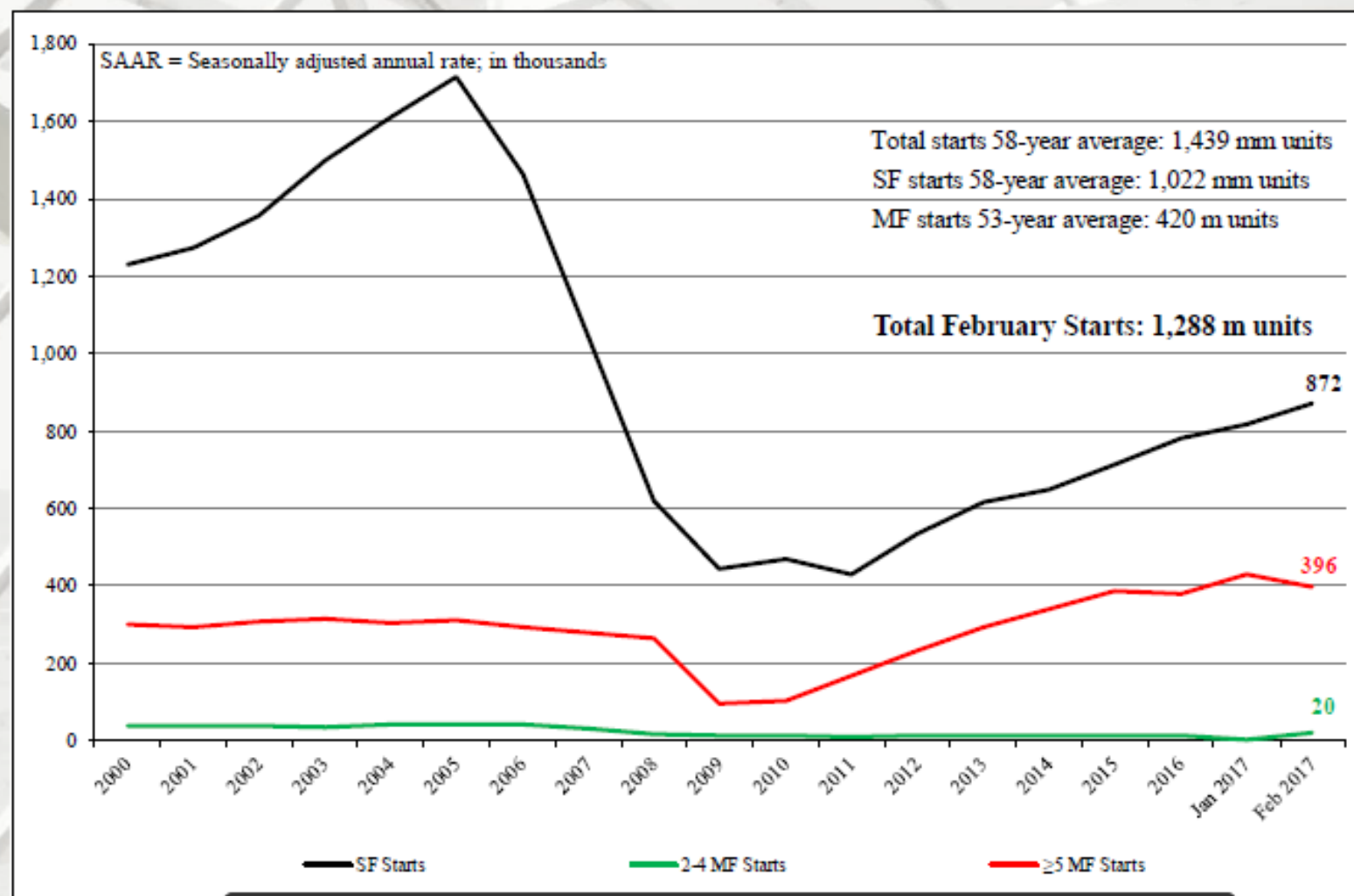


# U.S. Hardwood Lumber Statistics

(Luppold and Bumgardner, USFS 2016)



# Total Housing Starts



8

/ 84



# February 2017

## Housing Scorecard

	M/M	Y/Y
Housing Starts	△ 3.0%	△ 6.2%
Single-Family Starts	△ 6.5%	△ 3.2%
Housing Permits	▽ 6.2%	△ 4.4%
Single-Family Permits	△ 3.1%	△ 13.5%
Housing Completions	△ 5.4%	△ 8.7%
New Single-Family House Sales	△ 6.1%	△ 12.8%
Private Residential Construction Spending	△ 1.8%	△ 6.4%
Single-Family Construction Spending	△ 1.2%	△ 3.4%
Existing Home Sales	▽ 0.7%	△ 1.0%

M/M = month-over-month



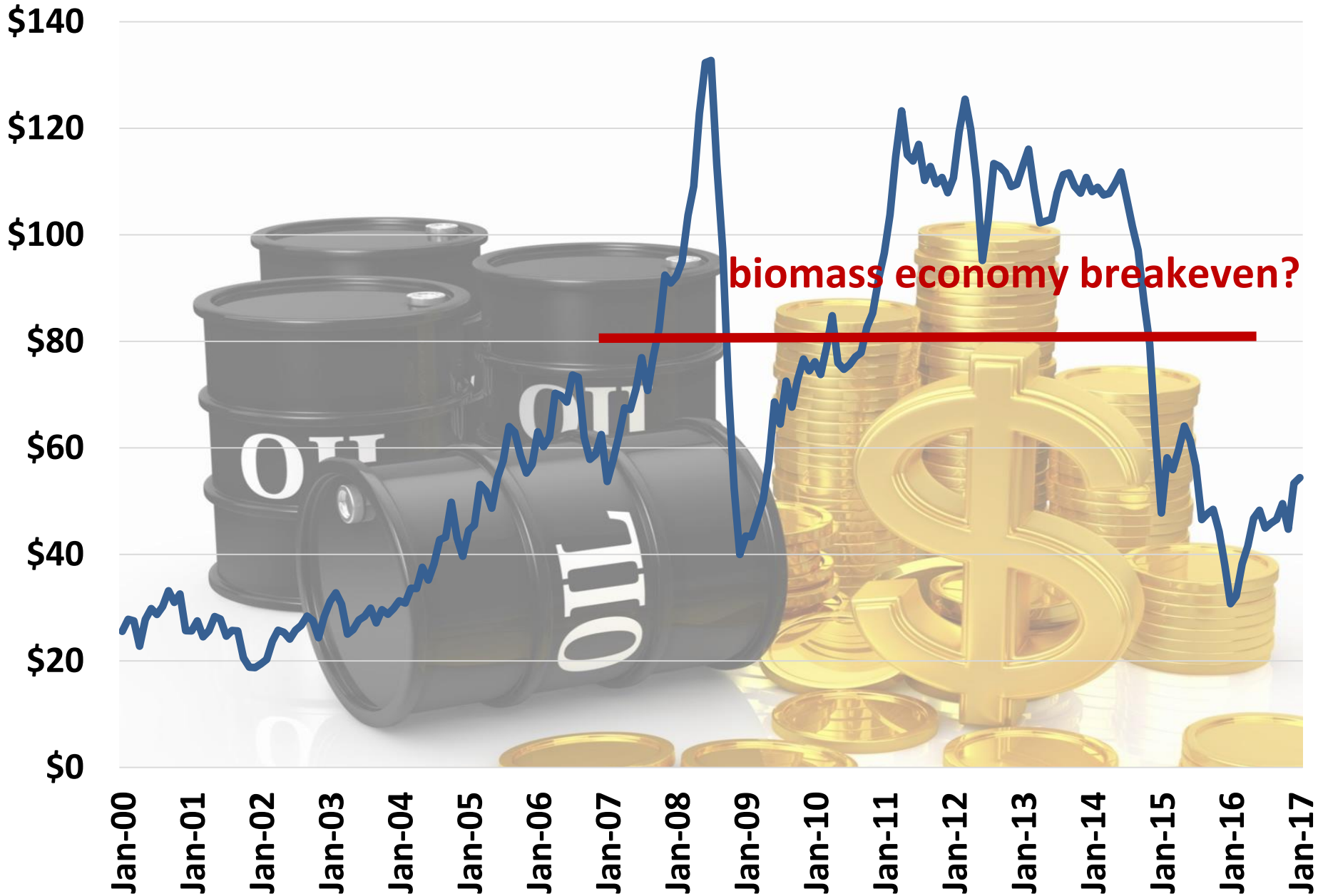
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# Brent Crude Oil Spot Price, USD per Barrel

Courtesy: D. Deckard 2017



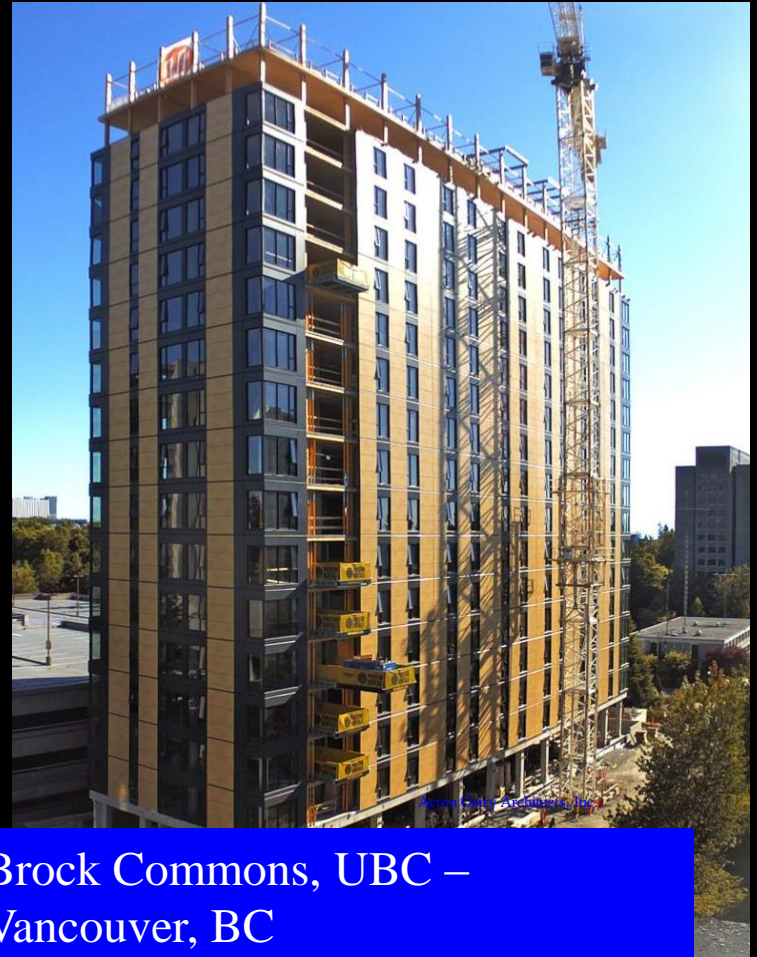


# Market Drivers

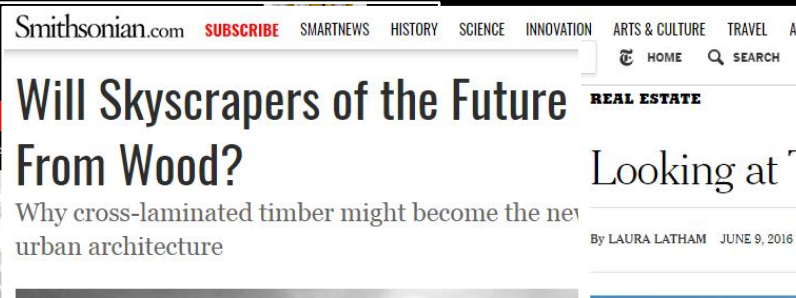
- Digital Economy – driving the downward spiral in domestic printing-writing papers and newsprint demand
- U.S. Housing – 2016 starts up only 4.9% y/y; rising home prices, interest rates, flat wages
- Oil – nearly all “new” biochemical and biofuel products are petroleum substitutes; only viable at \$80+ per barrel

# **EMERGING WOOD MARKETS**

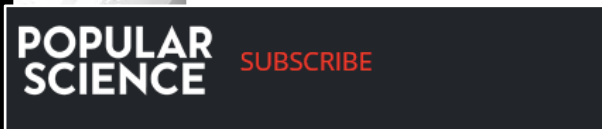
# Mass Timber



# The SECRET IS OUT!



## WOODEN BUILDINGS AS STRONG AS STEEL



ENVIRONMENT

## Wood-And-Glue Skyscrapers Are On

ate change



Forbes

SUNDAY MORNING

The Economist



# Mass Timber Framing Options

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Nail Laminated Timber (NLT)



Glue Laminated Timber (GLT)



Glulam Beams & Columns



Laminated Veneer Lumber (LVL)



Cross Laminated Timber (CLT)



Images Source: Structurecraft

# Mass Timber Products

## PARALLEL STRAND LUMBER

PSL is a composite of wood strands with fibers. The strongest and stiffest engineered wood product available, it is usually the most effective choice for large single beams. Unlike other heavy timber options, PSL is often used in exterior applications because it can be pressure treated.

## NAIL-LAMINATED TIMBER

NLT is created by stacking dimensional lumber together on its edge and fastening it together with nails. Plywood sheathing can be added to one side to allow the product to be used as a wall panel. It is cheaper than other heavy timber options and more widely accepted in building codes because it is simple to make and simple to understand.

## GLU-LAMINATED TIMBER

Glulam is an engineered product made of two or more layers of lumber glued together with the grain of all layers running parallel to the length. Its composition enables the production of a variety of sizes and shapes, including curves. Glulam's size is limited only by the manufacturing and transportation capabilities. Glulam has many advantages over sawn lumber, such

## CROSS-LAMINATED TIMBER

CLT consists of several boards stacked in alternating directions and glued together. To obtain specific structural capacities, consecutive layers may be placed in the same direction. A typical CLT cross-section contains three to seven boards.

Manufacturing Process

## HEAVY TIMBER

Heavy timber, by definition, must measure no less than 4" in width or 6" in depth. Any smaller pieces of structural lumber (such as 2x4's) are instead referred to as "dimensional lumber". Spans can be limited in heavy timber construction because

## PLYWOOD

Plywood is a panel product composed of an odd number of thin layers of peeled wood veneers, or plies. The layers are laid perpendicularly because alternating the grain reduces wood's tendency to split, expand, and shrink. This provides improved dimensional

## LAMINATED VENEER LUMBER

LVL is made up of layers of wood veneers, or plies, which are laminated together using waterproof structural adhesive. Though similar to plywood, LVL has plies that all run in the same direction (rather than alternating). A major advantage is that it can be

## LAMINATED STRAND LUMBER

LSL is a structural composite lumber manufactured from wood strands or flakes—either the same or different species—oriented parallel to the length and blended with an adhesive. It utilizes the same technology as OSB. Produced from smaller logs, LSL is more affordable than other heavy

# Mass Timber Strategy



## Education

- WoodWorks
- Mass Timber Conference
- Softwood Lumber Board
- Media

## Technical Assistance

- WoodWorks
- **Forest Products Marketing Unit (FPL)**
- **Regional Biomass Coordinators**

## Research

- **Forest Products Laboratory (FPL)** and University and other Research Partners

## Initiatives

- U.S. Tall Wood Building Competition
- National Building Museum
- Film with Choose Outdoors
- **Wood Innovation Grants**
- Cooperative Agreements

**Agency Lead:**  
Washington Office -  
Cooperative Forestry

AMERICAN NATIONAL STANDARD

# Standard for Performance-Rated Cross-Laminated Timber



## American National Standard

- Defines CLT
- Component requirements
- Performance criteria
- Qualification
- Quality assurance
- Terminology







*Photo Credit: D. R. Johnson*





*Photo Credit: D. R. Johnson*

# Non-building markets

- Industrial matting
  - Pipeline
  - Access mats
  - Crane
- Maritime decks
- Portable bridge decks



Photo Credit: Smartlam



# North American Manufacturing

## Canada

- Nordic Structures (Quebec)
- StructureCraft (BC)
- Structurlam (BC)

## United States

- DR Johnson (OR)
- Smartlam (MT)
- Sterling (IL) – industrial
- WA and OR Announcements

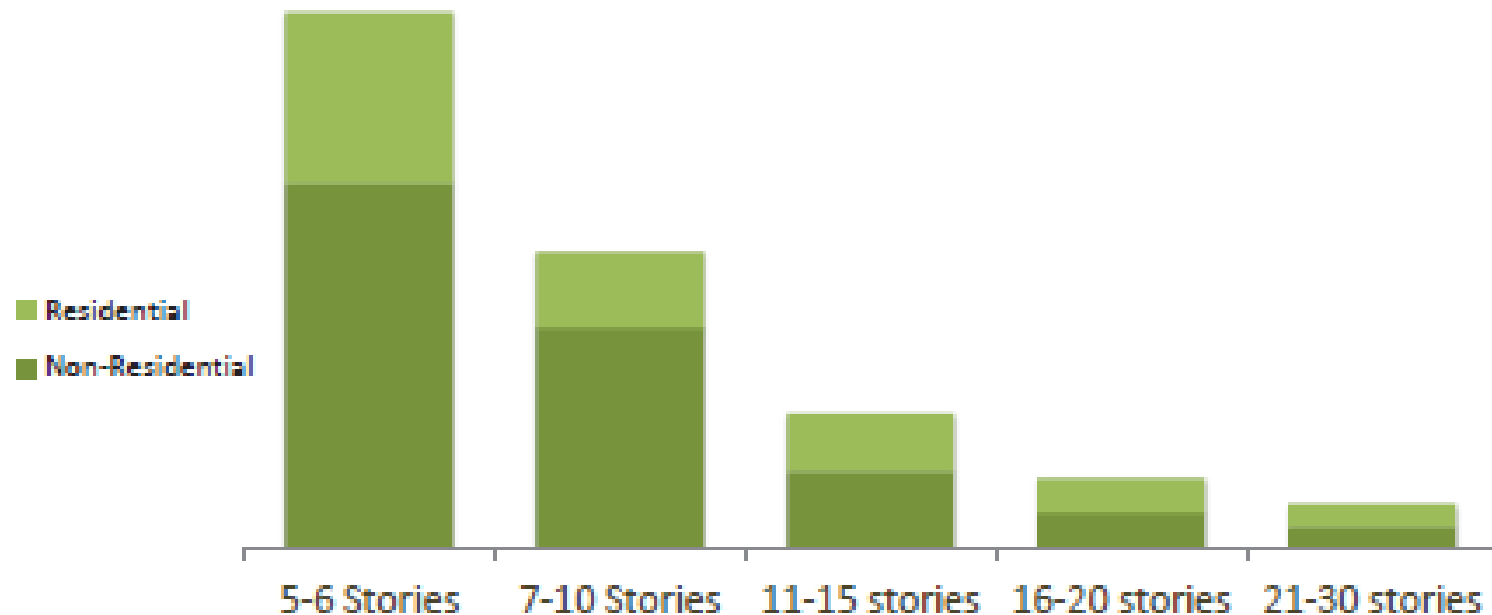




# Opportunity - Tall Wood



Incremental Volume: 5.0 BBF/Year



	5-6 Stories	7-10 Stories	11-15 stories	16-20 stories	21-30 stories
Non-Res	2.035 bbf	1.229 bbf	.425 bbf	.195 bbf	.113 bbf
Residential	.958 bbf	.420 bbf	.318 bbf	.192 bbf	.129 bbf
Total	2.003 bbf	1.649 bbf	.743 bbf	.387 bbf	.242 bbf

**T3 – Minneapolis, MN**







# BROCK COMMONS

UNIVERSITY OF BRITISH COLUMBIA

18-STOREY HYBRID MASS TIMBER  
STUDENT RESIDENCE

WOOD CONSTRUCTION:



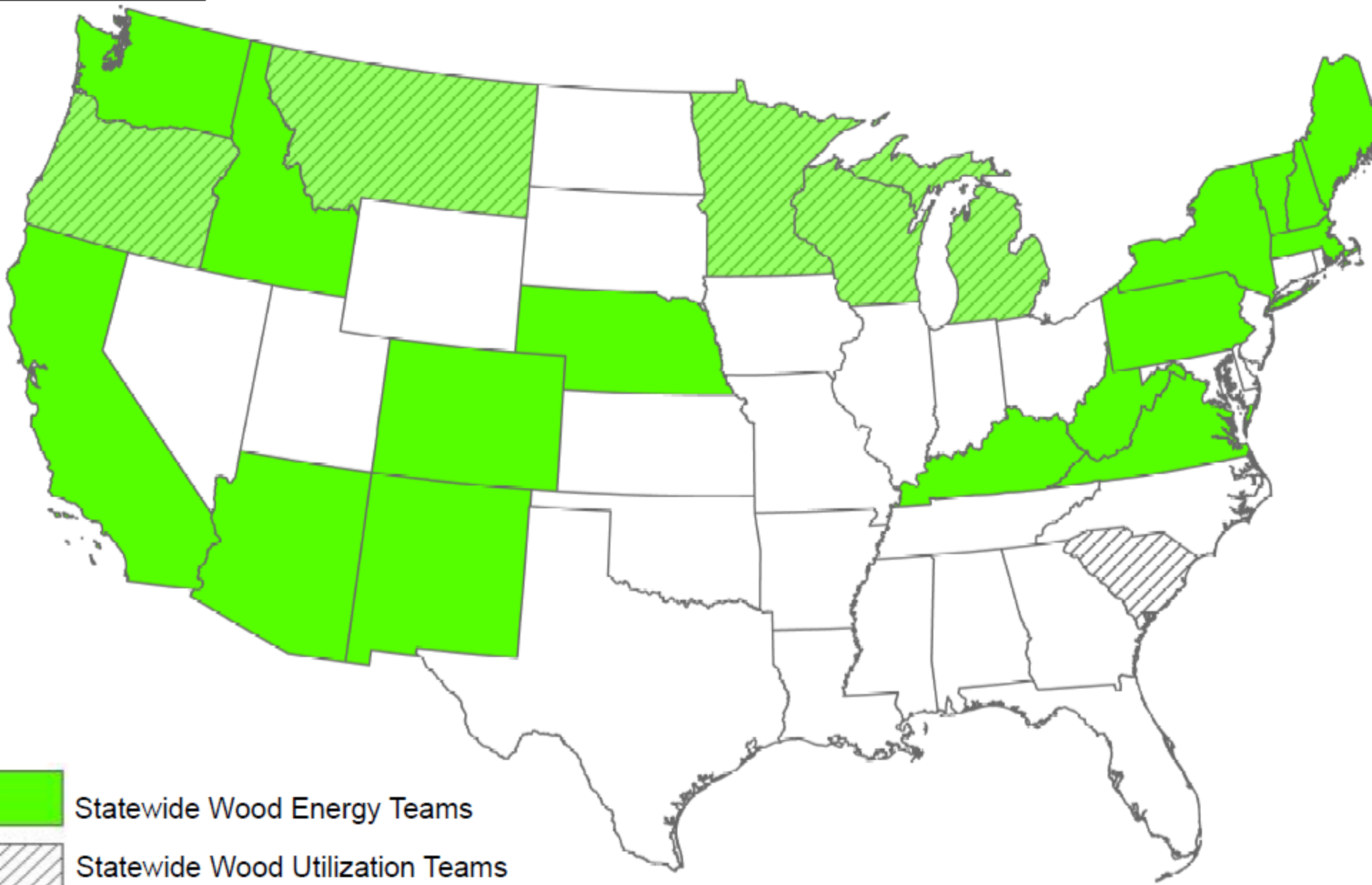
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[Brock Commons YouTube Time Lapse](#)



# Statewide Wood Energy Teams and Statewide Wood Utilization Teams



# Torrefaction of Woody Biomass



TORREFIED WOOD PELLETS



INDUSTRIAL WOOD PELLETS

**A Carbon  
Neutral  
Biomass Fuel  
That Performs  
Just Like Coal**



## Consortium for Advanced Wood-to- Energy Solutions



**U.S. Endowment**  
for Forestry and Communities



# What is Torrefaction?

- Heating in an oxygen deprived atmosphere (similar to coffee roasting)
- Temperatures: 270°C – 300°C
- Surfaces become hydrophobic
- Improved grind ability
- Improved calorific value







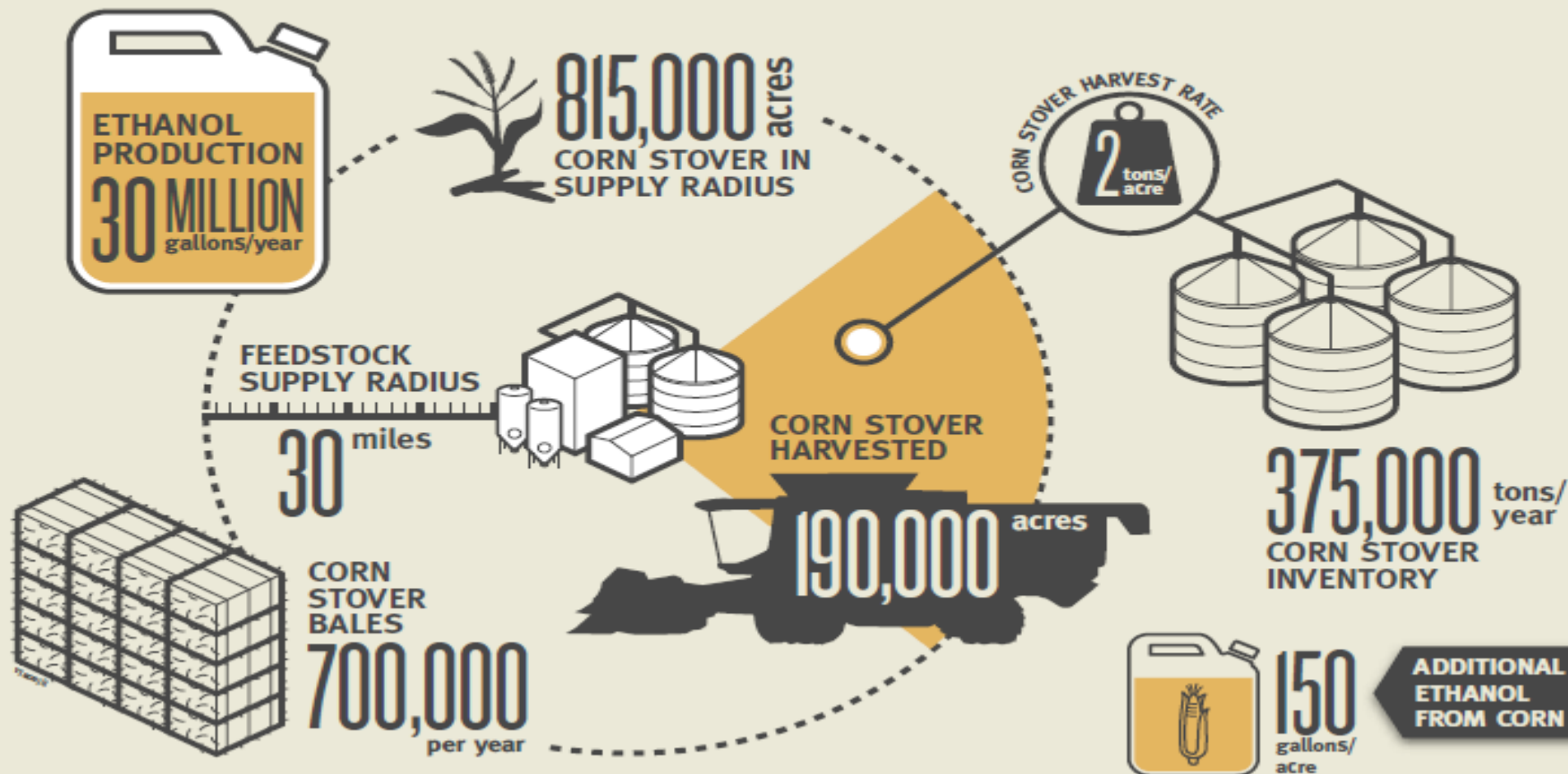


# Biochar Markets

## Making Cellulosic Ethanol a Reality: By the Numbers



The DuPont Nevada Site Cellulosic Ethanol Facility is expected to be completed in 2015. Situated in a prime agricultural location, this over \$200 million facility will be among the first commercial-scale cellulosic biorefineries in the world.



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# NARA

Northwest Advanced Renewables Alliance

## Alaska Airlines flies first commercial flight with new biofuel made from forest residuals





































Posted on November 14, 2016 By Alaska Airlines

19 Comments



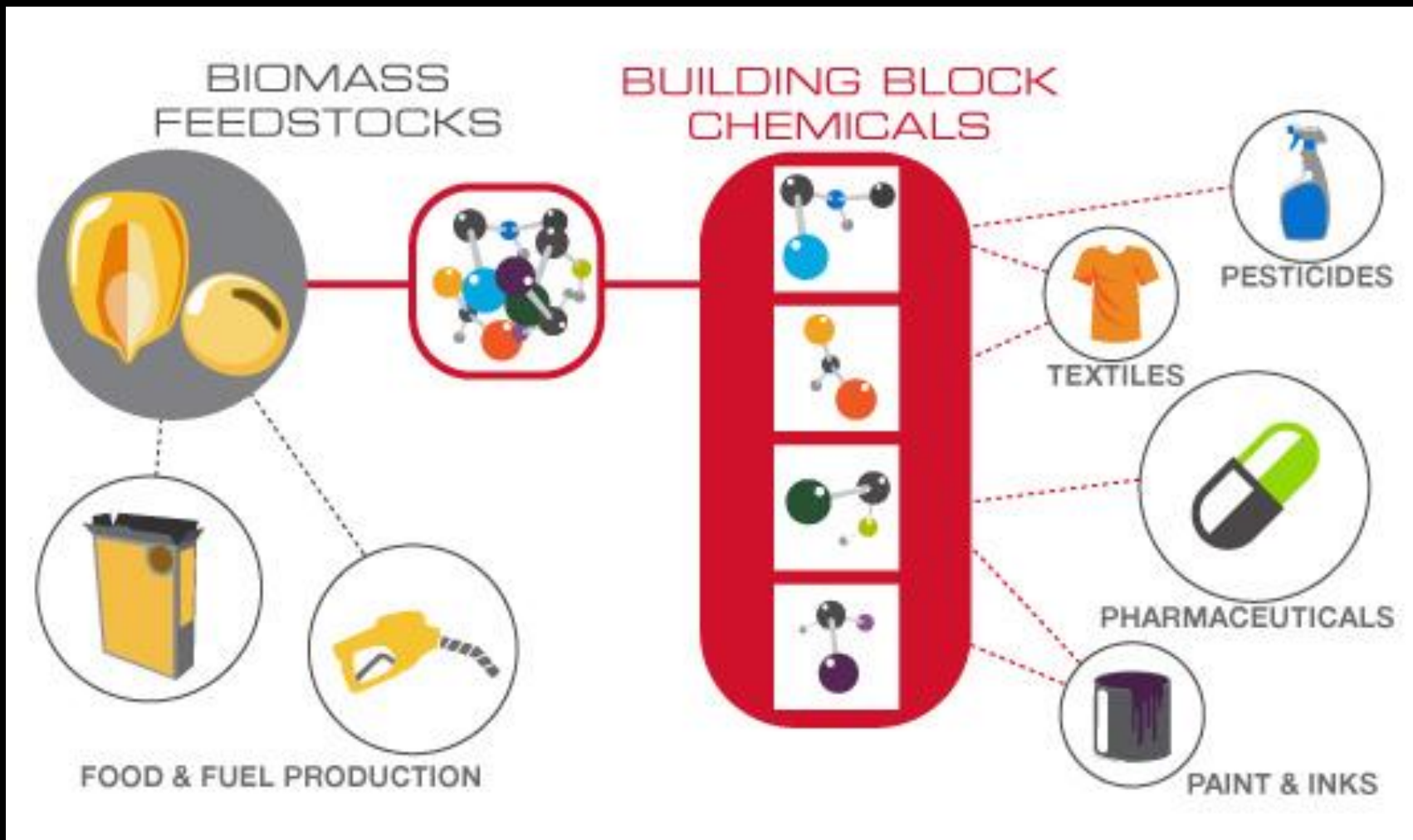


# SAJF OFFTAKE AGREEMENTS

PRODUCER	OFFTAKER(S)	NEAT QUANTITIES
	 UNITED  Gulfstream  Sky NRG  KLM  World Fuel	 5 M gpy from 2016  3 yr agreement 30/70 blend  3 yr agreement enabling LAX flts
	 CATHAY PACIFIC  UNITED	 375M usg  90-180 M gpy over 10 yrs
	 Southwest  FedEx	 3 M gpy  3 M gpy
 TOTAL    AMYRIS	 CATHAY PACIFIC	 48 A350 deliveries 10% blend
		 10M gpy, 10 yrs
		 Up to 40M gal over 5 yrs (MOU)
	 SKY NRG  SAS  OSL  KLM  Lufthansa Group	 (Bioport on demand)







## BIOBASED VALUE CHAINS

### OIL BARREL

DIESEL  
JET FUEL  
OTHER PRODUCTS  
HEAVY FUEL OIL  
LPG  
GASOLINE



### SUGAR BARREL

OTHER  
LIGNIN  
XYLOSE  
GLUCOSE





# SWEETWATER ENERGY

## BIOMASS COLLECTION



Sweetwater utilizes a variety of different low-value organic materials to create highly fermentable cellulosic derived sugars and clean high-value lignin fiber.

[See in Action >](#)

## BIOMASS COMPONENTS



All lignocellulosic biomass is comprised of three main components: cellulose, hemicellulose, and lignin.

[See in Action >](#)

## BIOMASS SLURRY



The chosen biomass will begin its journey through the Sweetwater process with a water and dilute acid soak.

[See in Action >](#)

## HEMI-HYDROLYSIS



The hydrated biomass is then moved through pretreatment where an exceptionally controlled hemi-hydrolysis releases the maximum amount of monomeric pentose sugars.

[See in Action >](#)

## COMMERCIAL APPLICATIONS



Both Sweetwater sugars and clean lignin can be used in a wide variety of commercial products including biofuels, biochemicals and biomaterials.

[See in Action >](#)

## POST-HYDROLYSIS



The resulting sugar stream is separated from the high value, clean lignin fiber byproduct and customized to each individual customer's specifications.

[See in Action >](#)

## CELLULOSE HYDROLYSIS



Optimally pretreated biomass is enzymatically hydrolyzed to release the maximum amount of glucose monomers in a minimal amount of time.

[See in Action >](#)

## SOLID / LIQUID SEPARATION



After pretreatment, Sweetwater has the ability to separate the C5 sugars that were solubilized during pretreatment for commercial applications in pentose-derived bio-products.

[See in Action >](#)



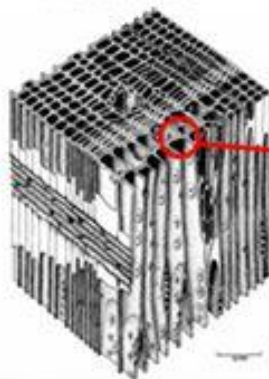


# “What is Woody Nano-Material?”

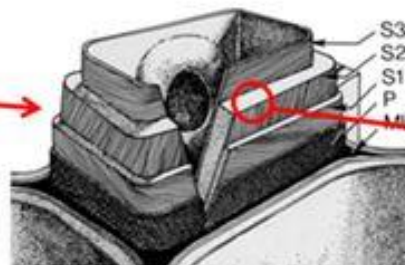
Forest products, biomass



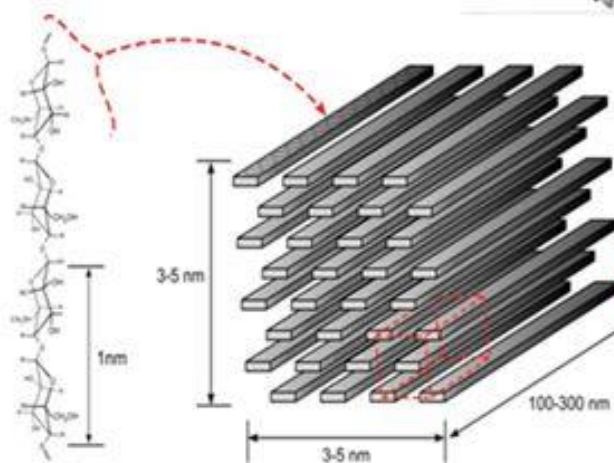
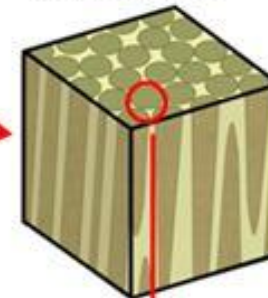
Wood cells



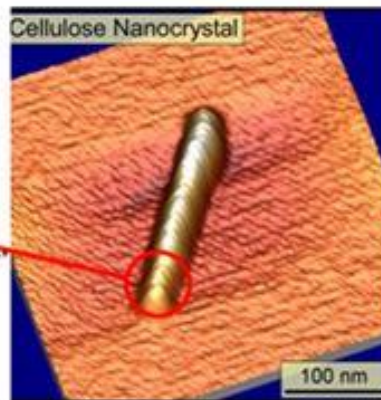
Cell wall layers



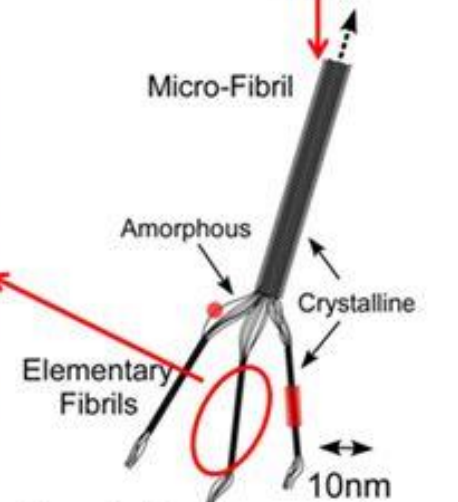
Cellulose microfibrils  
In cell walls



CNC's consist of organized stacks of  $I_{\alpha}$ ,  $I_{\beta}$  cellulose chains



AFM image of a cellulose Nanocrystal (CNC)



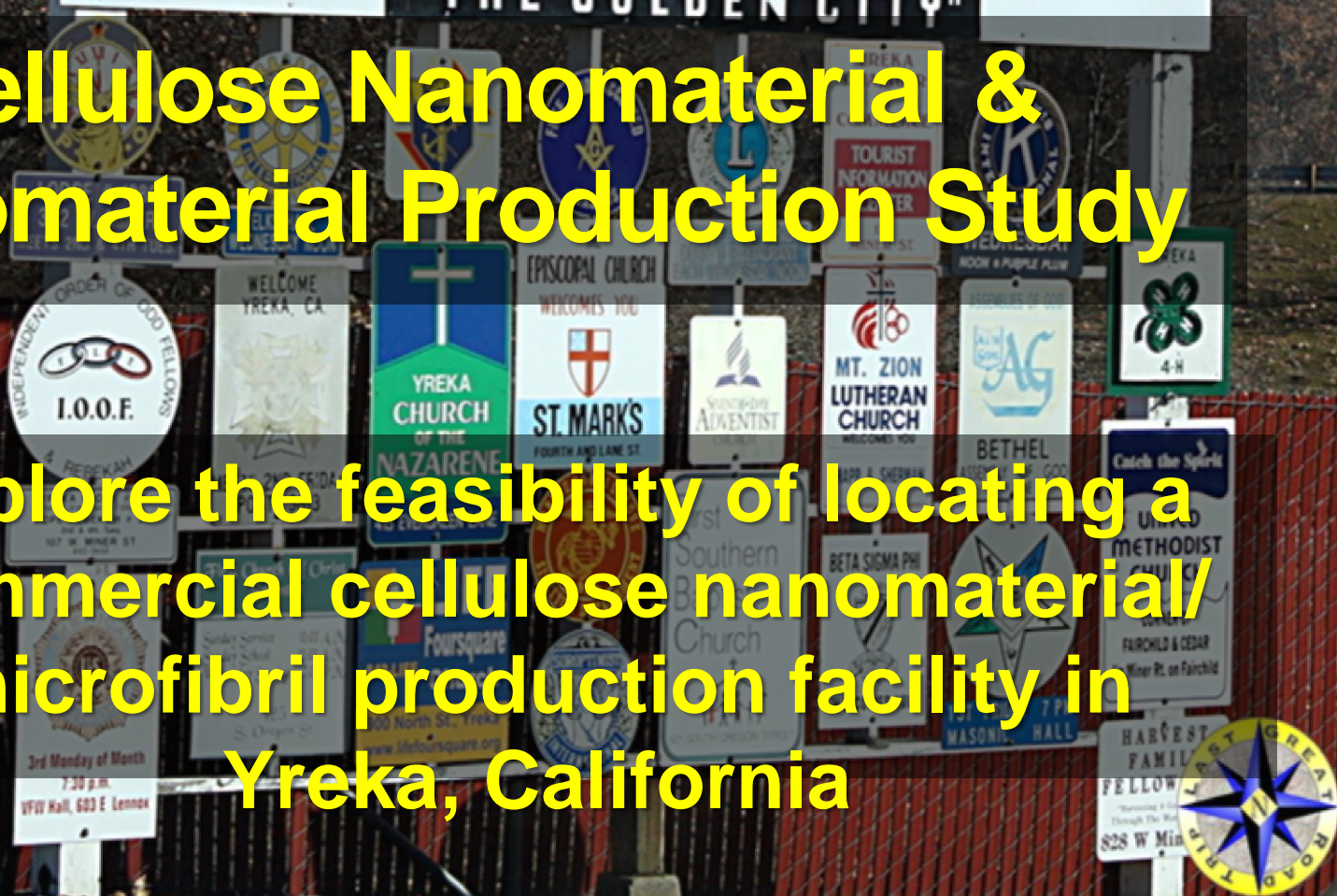
Chemical treatment releases crystalline phase





# Cellulose Nanomaterial & Micromaterial Production Study

Explore the feasibility of locating a commercial cellulose nanomaterial/microfibril production facility in Yreka, California



# Yreka Specific Project Goals

1. Compare quality and performance characteristics of cellulose nanomaterials and cellulose micromaterials made directly from wood
2. Identify production site requirements (such as water use, water treatment)
3. Determine production costs (capital and operating) for the cellulose nano- or microparticle intermediates
4. Produce quantities of cellulose nano- and micromaterials sufficient to evaluate four applications
5. Interface with Forest Service Pacific Southwest Region and local economic development groups

HIGH VOLUME	LOW VOLUME	NOVEL & EMERGING APPLICATIONS
Cement/Concrete	Wallboard Facing	Sensors – medical, environmental, industrial
Automotive Body	Insulation/SIPS	Reinforcement fiber - construction
Automotive Interior	Aerospace Structure	Water filtration
Packaging Coatings	Aerospace Interiors	Air filtration
Coatings	Aerogels for the Oil and Gas Industry	Viscosity modifiers
Paper Filler	Paint-Architectural	Purification
Packaging Filler	Paint-Special Purpose	Cosmetics
Replacement -Plastic Packaging	Paint -OEM Applications	Excipients (Drug delivery)
Plastic Film Replacement		Organic LEDs
Hygiene and Absorbent Products		Flexible Electronics
Textiles for Clothing		Photo-voltaics
Market Projections Of Cellulose Nanomaterial-Enabled Products- Part 1: Applications		Recyclable Electronics
		3D printing (Additive Mfg.)
		Photonic Films
TAPPI JOURNAL, Volume 13, Number 5, 2014; pp. 9-16		



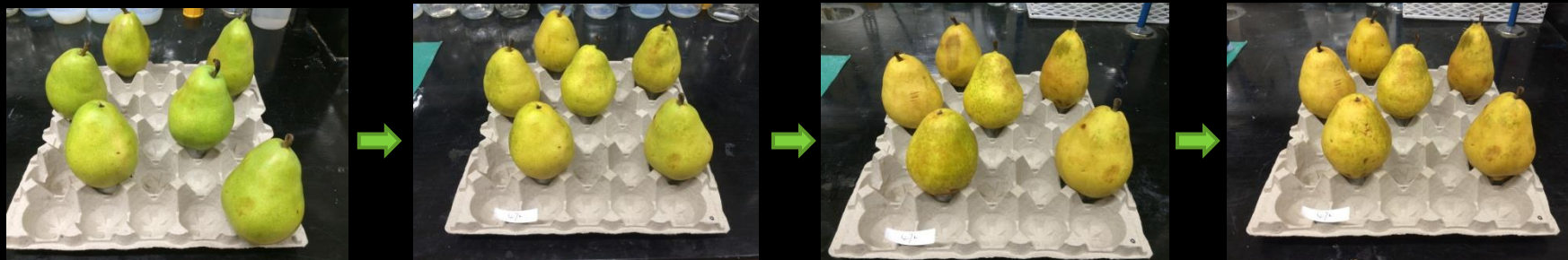
# Use of CNC in Concrete

- 0.7% CNC addition to cement results in a 20% increase in strength
  - ▶ Flexural strength
  - ▶ Plasticizer
  - ▶ Rheology modifier
- Oregon State University -- Jason Weiss
- Purdue University -- Jeff Youngblood
- FPL & Georgia Tech -- Robert Moon

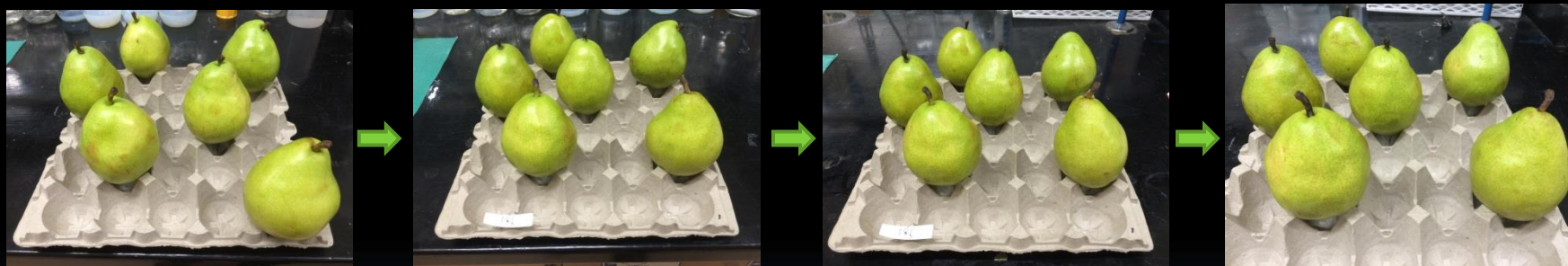


# Coatings -- Pears

## Uncoated



## Coated



**Week 0**

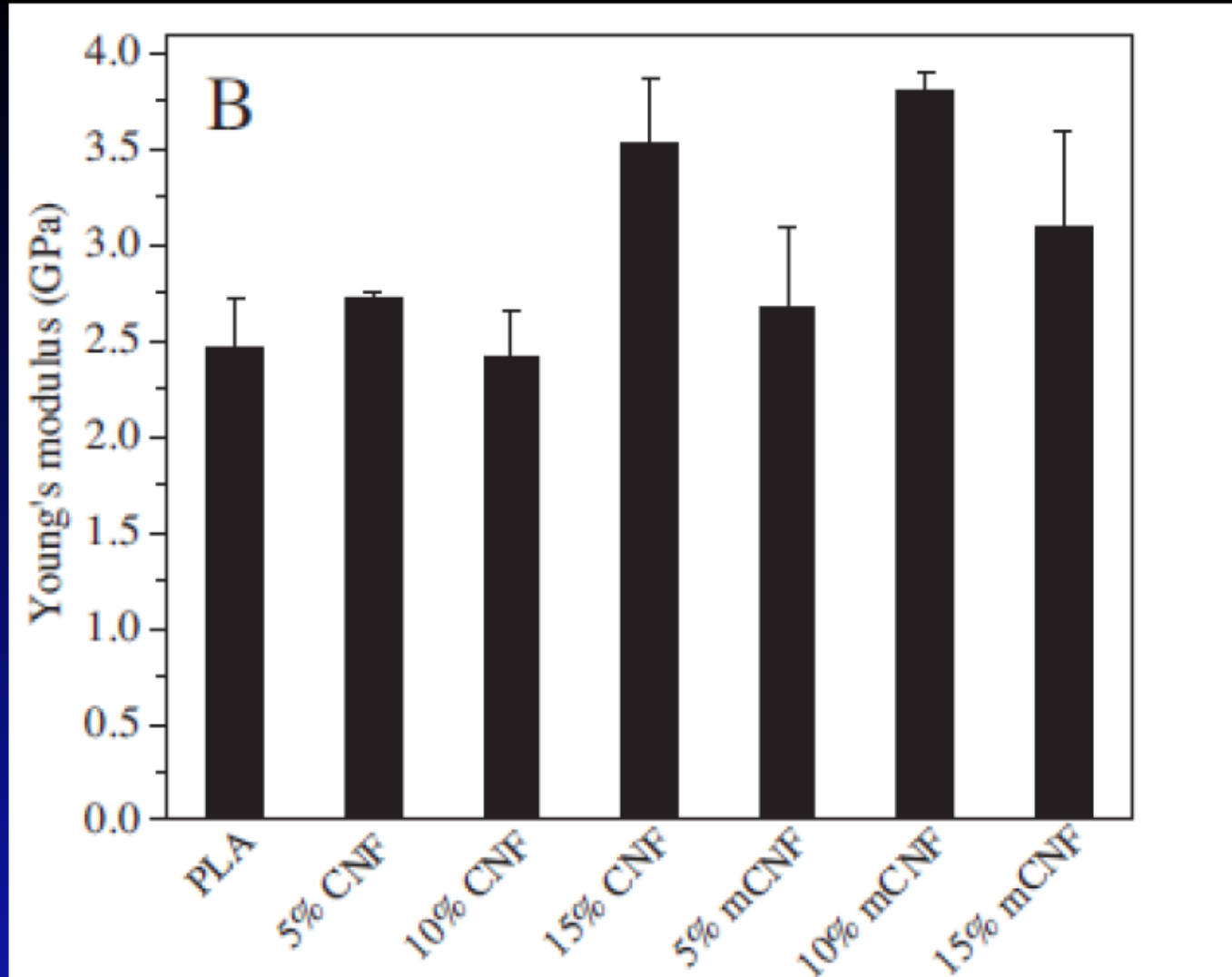
**Week 1**

**Week 2**

**Week 3**

Photos of pears uncoated vs. Innofresh coating at ambient condition ( $20\pm 2^{\circ}\text{C}$  and  $30\pm 2\%$  relative humidity) for three weeks

# Polymer Reinforcement — Packaging & Automotive Applications







# Nano-materials Pilot Plants

University of Maine  
and  
Forest Products  
Laboratory

- ✓ Cellulose Nanofibrils:  
1 ton / day (U of Maine)
- ✓ Cellulose Nanocrystals:  
40 lbs / 3 days (FPL)



# WRAP - UP

- Construction markets essential to demand
- Markets for all products important
- Innovation efforts are progressing
  - CLT
  - Bioproducts
- Key partnerships



***Thank you!***



**Brian Brashaw, PhD**  
Program Manager



**United States Department of Agriculture**  
Forest Service  
Forest Products Marketing Unit



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