Building Bigger, Taller and Smarter with Wood

Iain Macdonald
TallWood Design Institute

Oregon State University OSU

TALLWOOD DESIGN INSTITUTE

University of Oregon

Outline

- Mass timber – what and why?
- European origins
- Worldwide growth
- Mass timber in the US
- The future

TallWood Design Institute

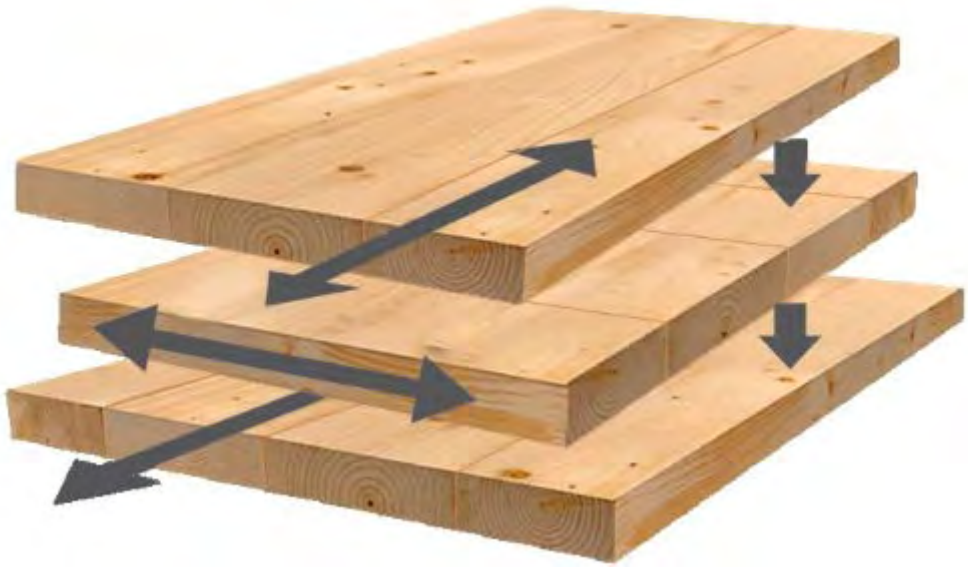
An industry-driven partnership between:

- College of Forestry, Oregon State University
- College of Design, University of Oregon
- College of Engineering, Oregon State University

Our Purpose

1. Grow the manufacturing base for structural wood products – especially mass timber - in Oregon and the Northwest US
2. Eliminate barriers and stimulate demand for structural wood products and building systems throughout the US

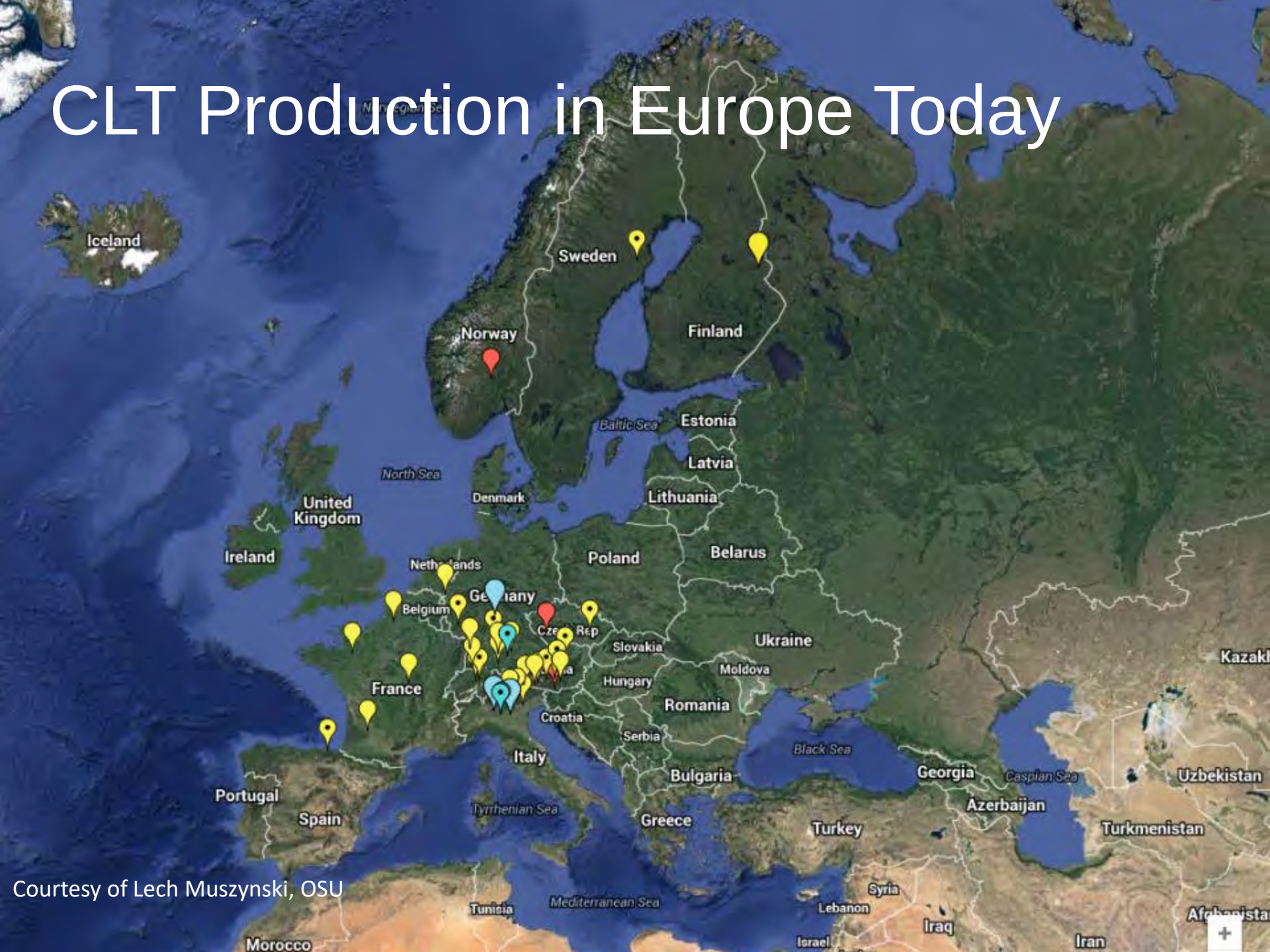
CLT – “plywood on steroids”?



Origins of CLT

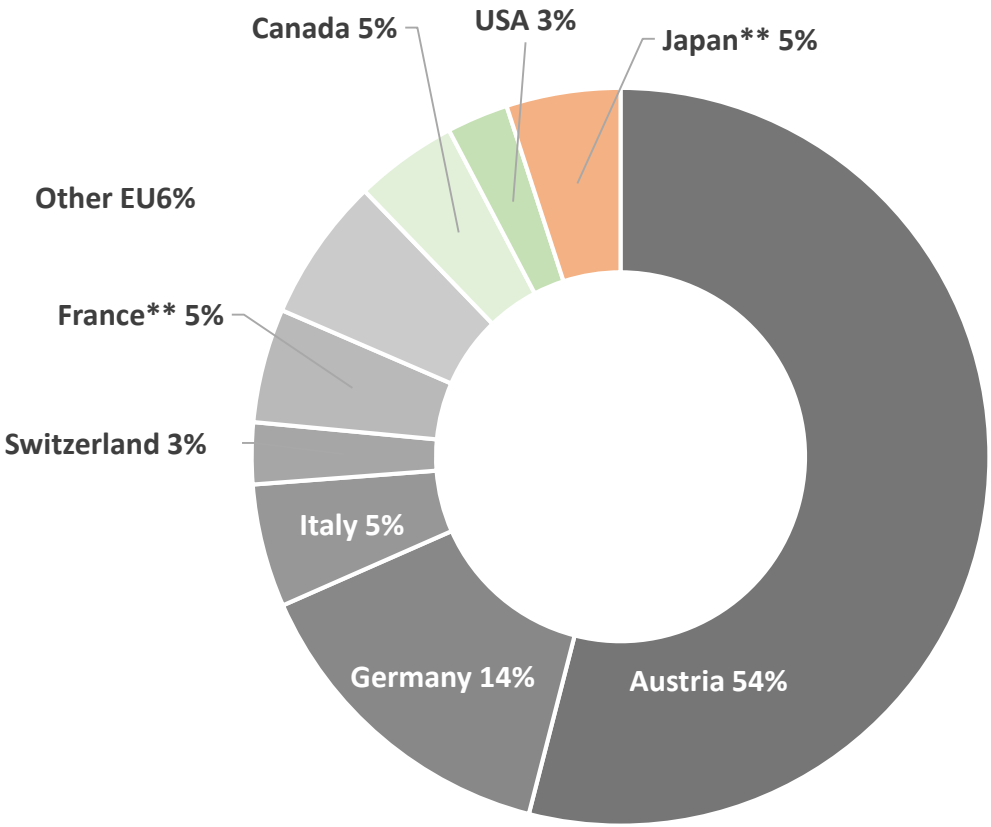
- Developed as a high-value use for side lumber from sawmilling processes
- Intensive Austrian research at University of Graz by Gerhard Schickhofer and others – mid to late 1990s
- First CLT buildings – 1993-95 – Germany & Switzerland
- KLH founded in 1997 – now worldwide market leader

CLT Production in Europe Today



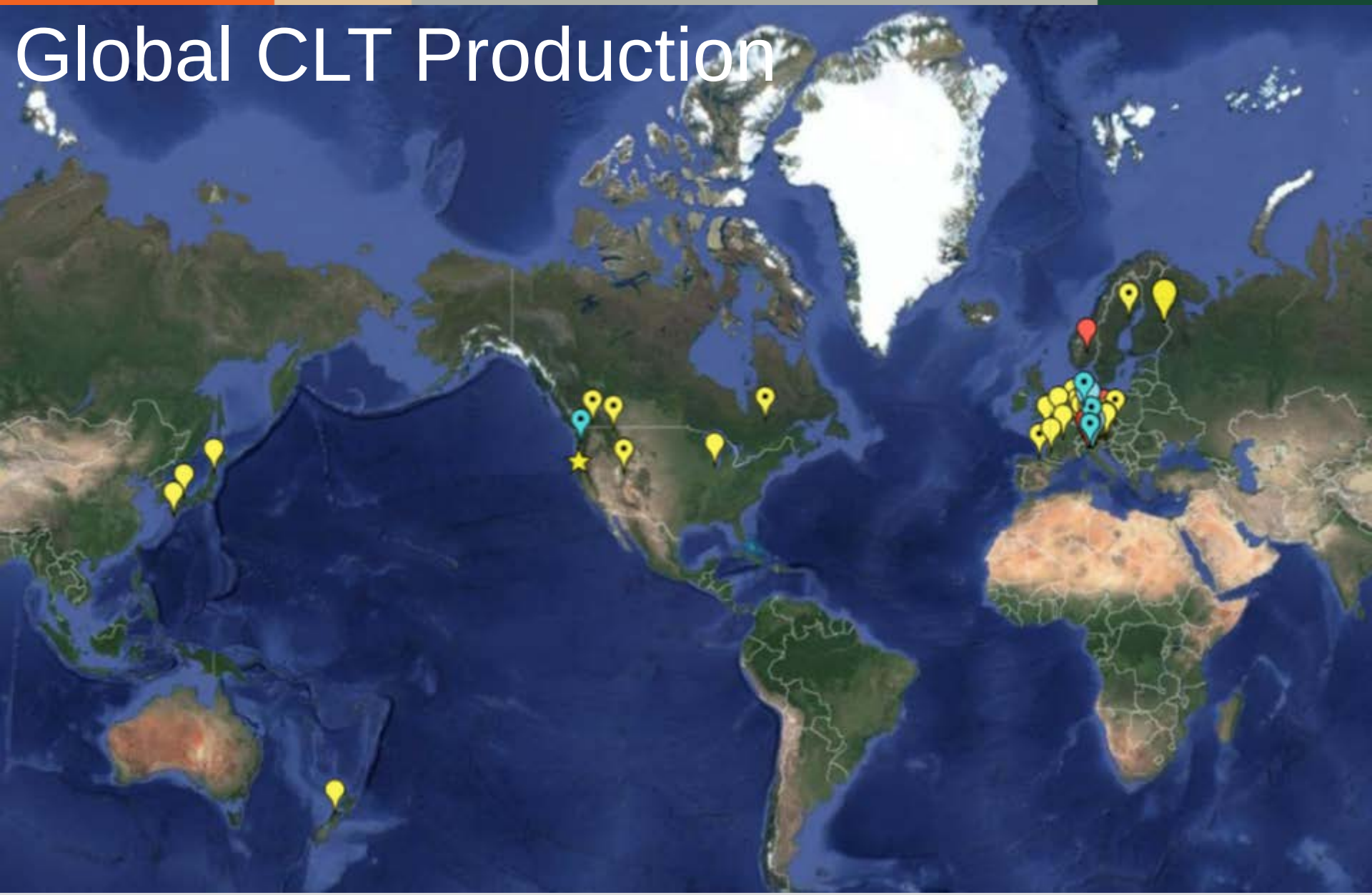
Courtesy of Lech Muszynski, OSU

Estimated Global Output

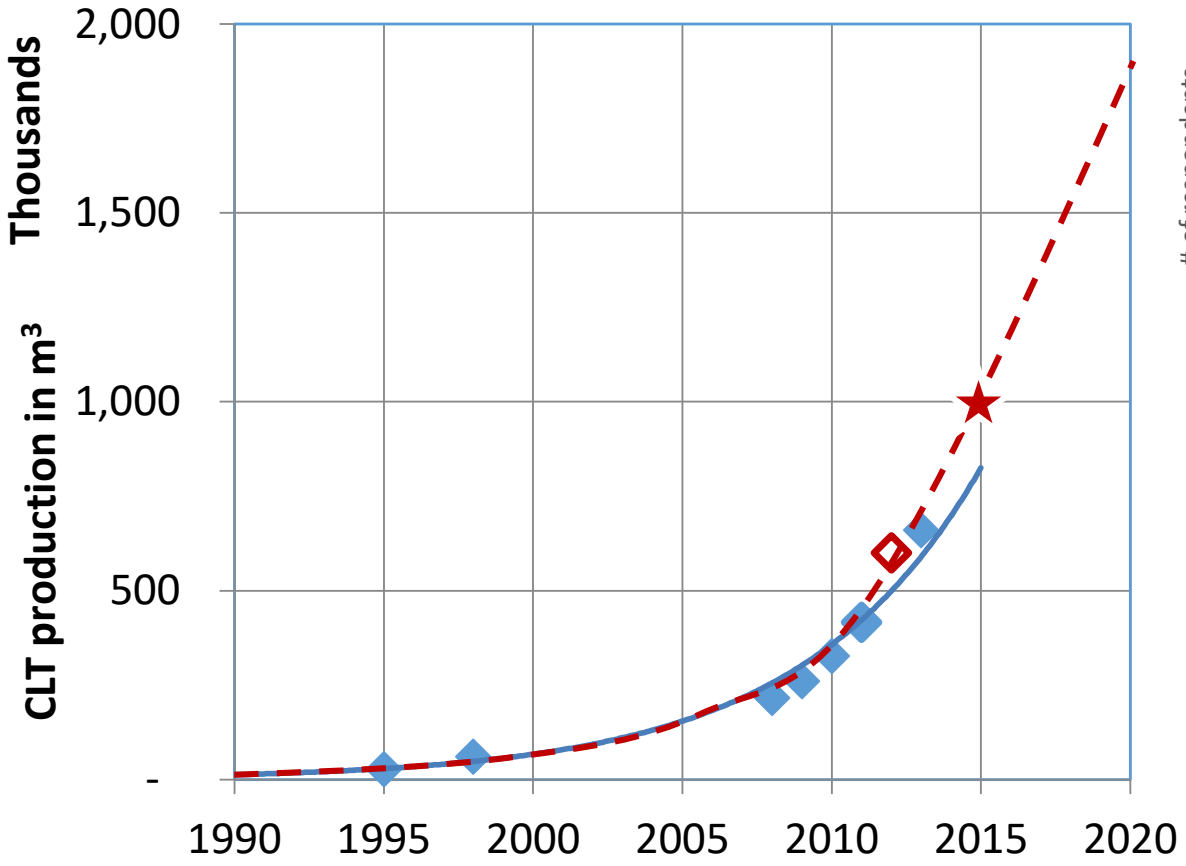


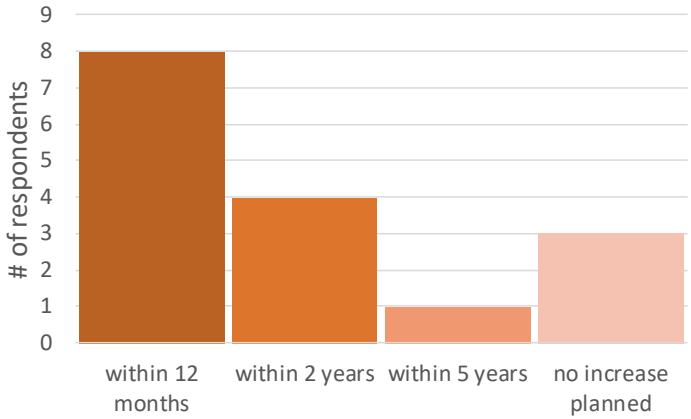
Muszynski 2017

Global CLT Production



Market Growth

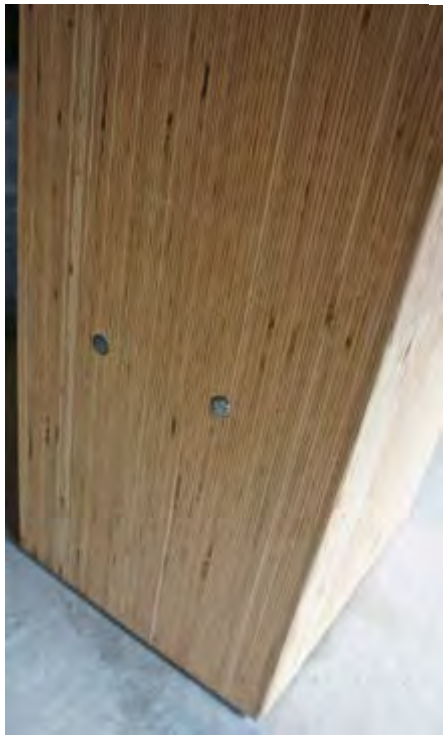




35.3 M CFT
OR
424 M BF

Muszynski 2016, based on Schickhofer 2010, Holzkurier 2011, 2015 & OSU Global Industry Survey 2016

Mass timber is not just CLT



Why Build Bigger with Wood?

- 50% of the world's population live in cities today
- 75% will be urban dwellers by 2040
- 3 billion people will need a new home in next 20 years

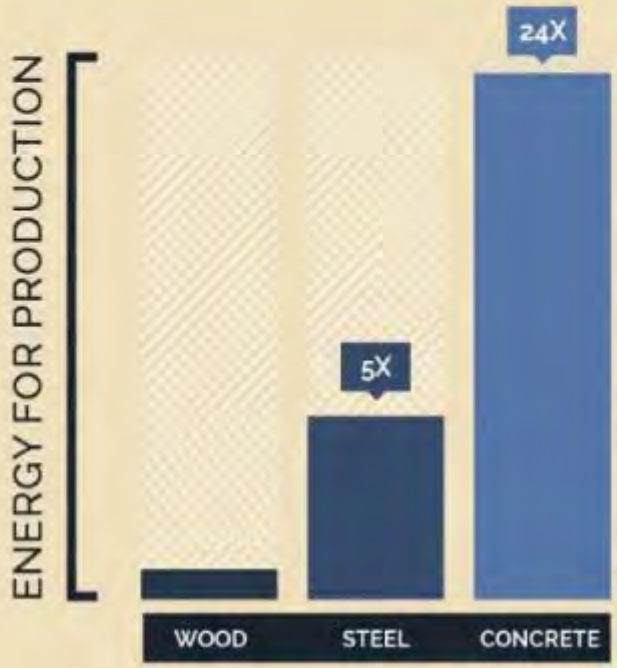
Image: theconversation.com

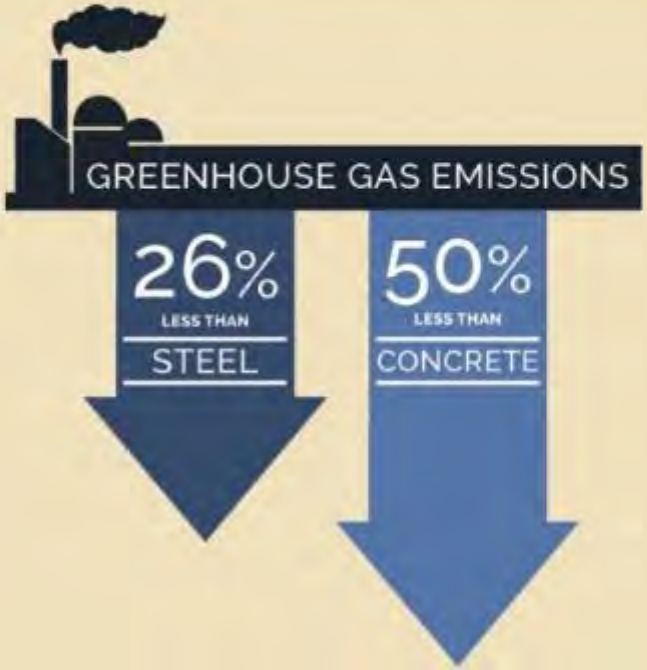
Urban Growth vs Climate Change

- 47% of GHGs come from buildings
- 33% from transportation
- 19% from industry

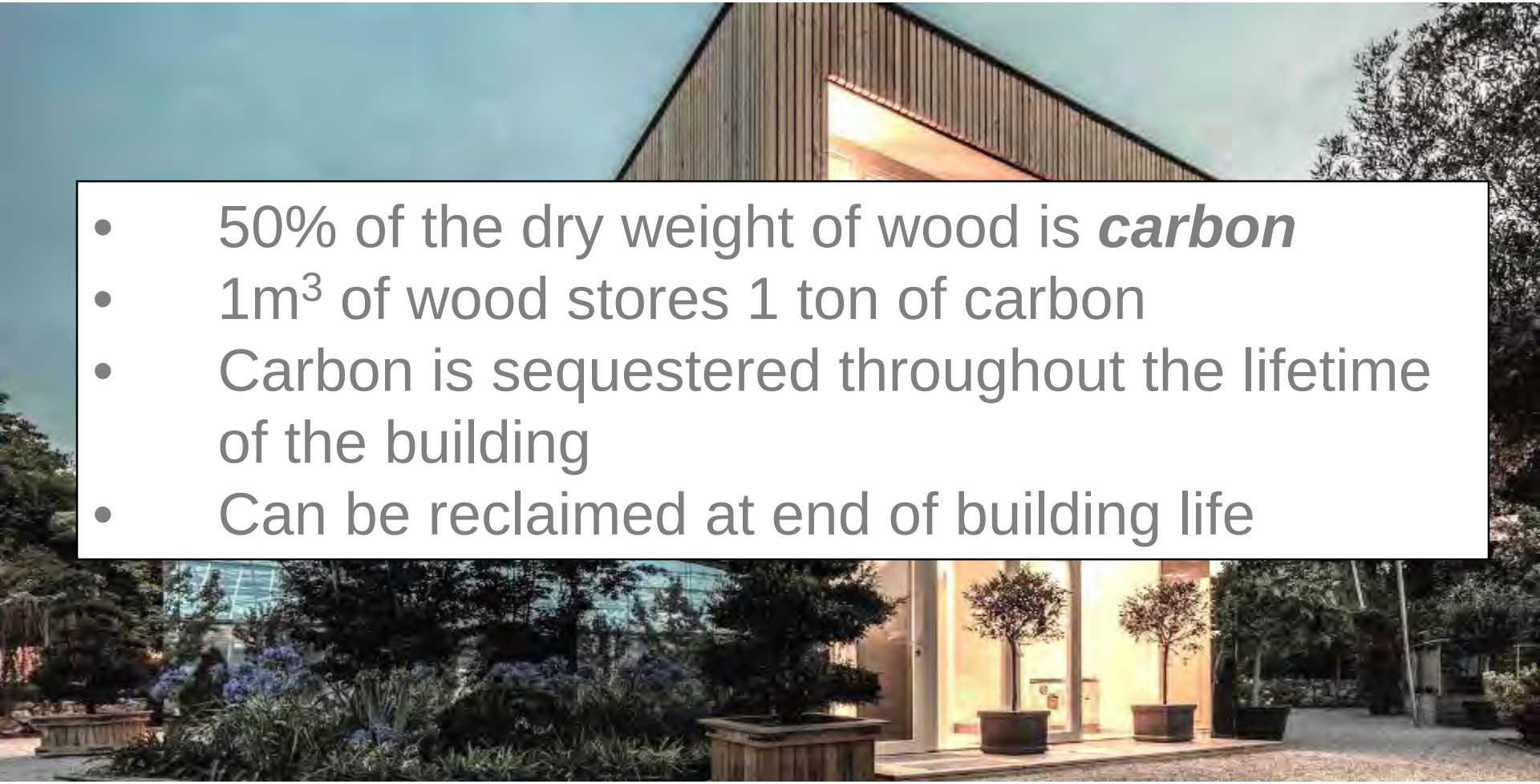
BENEFITS OF BUILDING WITH **WOOD**

Wood and wood products need the least amount of energy to manufacture and has the lowest impact on air and water quality.





Environmental Benefits During Service



- 50% of the dry weight of wood is ***carbon***
- $1m^3$ of wood stores 1 ton of carbon
- Carbon is sequestered throughout the lifetime of the building
- Can be reclaimed at end of building life

Economic Benefits

- Offsite prefabrication saves jobsite labor
- Up to 75% lighter than a concrete building = reduced foundation sizes and easier material handling
- Less deliveries, simplified jobsite logistics
- Less jobsite waste

PHOTOGRAPHY BY WILL PRICE

THE BUILDING BLOCKS

The panels, made of three or five layers, are up to 8 inches thick and 30 feet long. But thicker and bigger panels can be made.

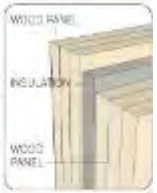
Cross section of a cross-laminated timber panel

IN CASE OF FIRE

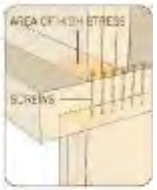
When massive solid-wood panels burn, their surface becomes charred. Charring can slow the fire and protect the inner core from heating, keeping it structurally sound. Panels with more layers of wood last longer in a fire. Typically walls and ceilings are covered with plasterboard to further reduce risk of the fire.

A CLOSER LOOK

INSTALLING ELEMENTS
Floors and walls can be lifted in place with a mobile crane. Metal brackets and screws are used to join panels together.



ELEVATOR SHAFT
For fire safety and soundproofing, the elevator shafts and stairwells have double walls with an insulating layer between.



ADDING STRENGTH
In areas of high stress where walls press into the floor, additional screws or nails can be driven into the floor to distribute the surface load deeper into the panel.

Arbora
Montréal, Canada
8 Stories
2016

Moholt 50/50
Trondheim, Norway
9 Stories
2016

Banyan Wharf
London, UK
10 Stories
2015

Hypérion
Bordeaux, France
18 Stories
2020

Silva
Bordeaux, France
18 Stories
Under Construction

5 King
Australia
10 Stories
Under Construction

Puukuokka
Jyväskylä, Finland
8 Stories
2015

TREET
Bergen, Norway
14 Stories
2015

Strandparken
Stockholm, Sweden
8 Stories
2014

Mjøstårnet
Norway
18 Stories
Under Construction

HoHo Vienna
Vienna, Austria
24 Stories
Proposed

Haut
Amsterdam, Netherlands
21 Stories
Proposed

Contralaminada
Lleida, Spain
8 Stories
2014

Wood Innovation & Design Centre
British Columbia, Canada
8 Stories
2014

St. Dié-des-Vosges
St. Dié-des-Vosges
8 Stories
2014

Framework
Portland, United States
12 Stories
Design Phase

Santuary
Glasgow, Scotland
7 Stories
2018

Sida Vid Sida
Skellaftea, Sweden
19 Stories
Announced

Cenni di Cambiamento
Milan, Italy
9 Stories
2013

Wagramerstrasse
Vienna, Austria
7 Stories
2013

Panorama Giustinelli
Triste, Italy
7 Stories
2013

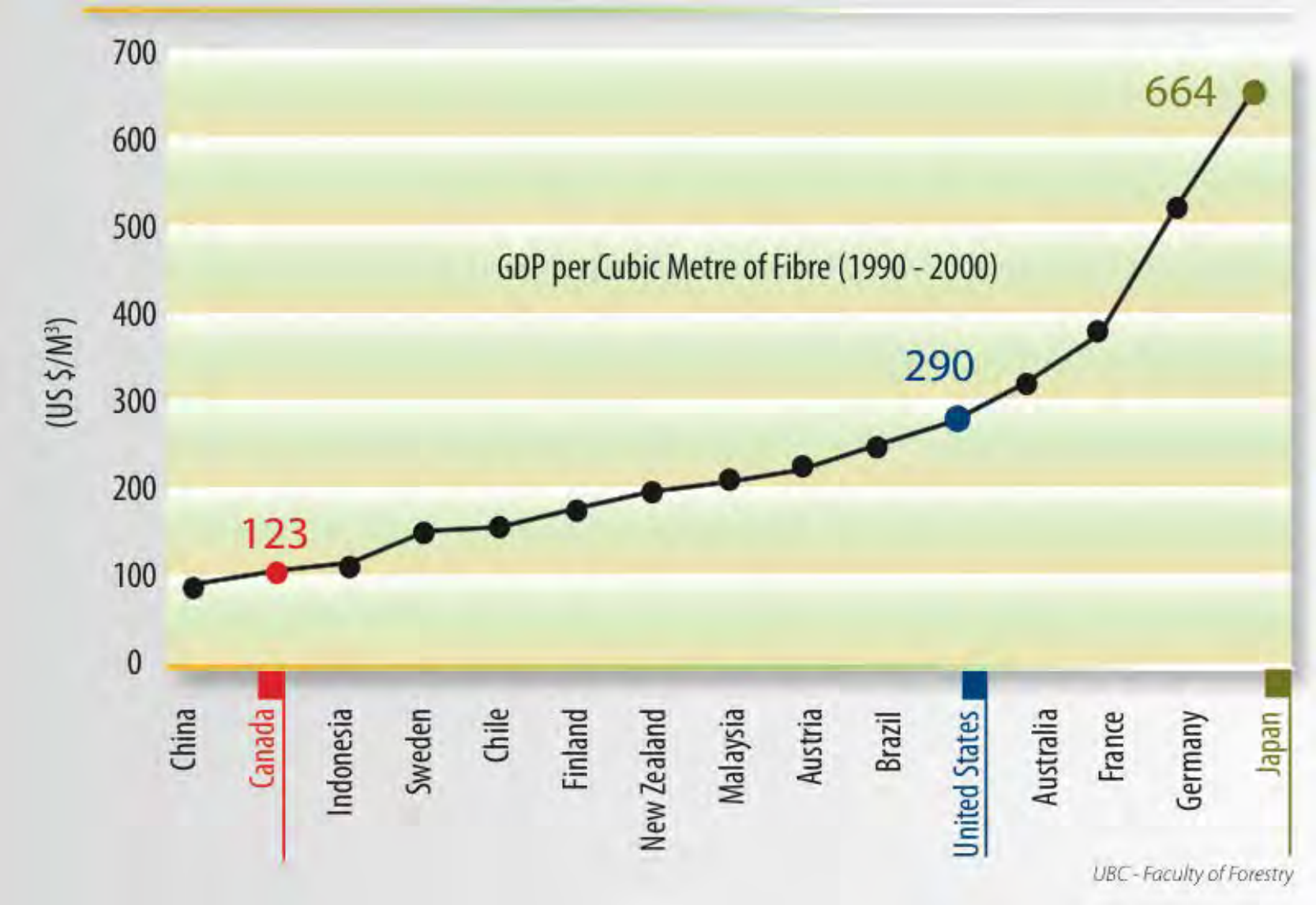
Brock Commons Tallwood House
Vancouver, Canada
18 Stories
2017

Origine Condos
Quebec City, Canada
13 Stories
2017

T3
Minnesota, United States
7 Stories
2016

Canada – Pioneering Steps

- Wood First Act – 2009 - required wood to be considered as the primary building material in all new publicly-funded buildings
- In an average year, BC funds almost $3 billion in capital investments in hospitals, schools, social housing, etc.
- 2010 Winter Olympics used as springboard
- 6-storey light frame wood buildings allowed under code since 2009 in BC and Quebec first, now more broadly
- 53 BC municipalities representing 1.1M people passed similar Wood First bylaws/resolutions


GDP per Cubic Metre of Fibre (1990 - 2000)
(US $/M³)
700
600
500
400
300
200
100
0
664
290
123
China
Canada
Indonesia
Sweden
Chile
Finland
New Zealand
Malaysia
Austria
Brazil
United States
Australia
France
Germany
Japan
UBC - Faculty of Forestry

Oregon State UNIVERSITY OSU

TALLWOOD DESIGN INSTITUTE

UNIVERSITY OF OREGON

Oregon State University OSU

TALLWOOD DESIGN INSTITUTE

UNIVERSITY OF OREGON

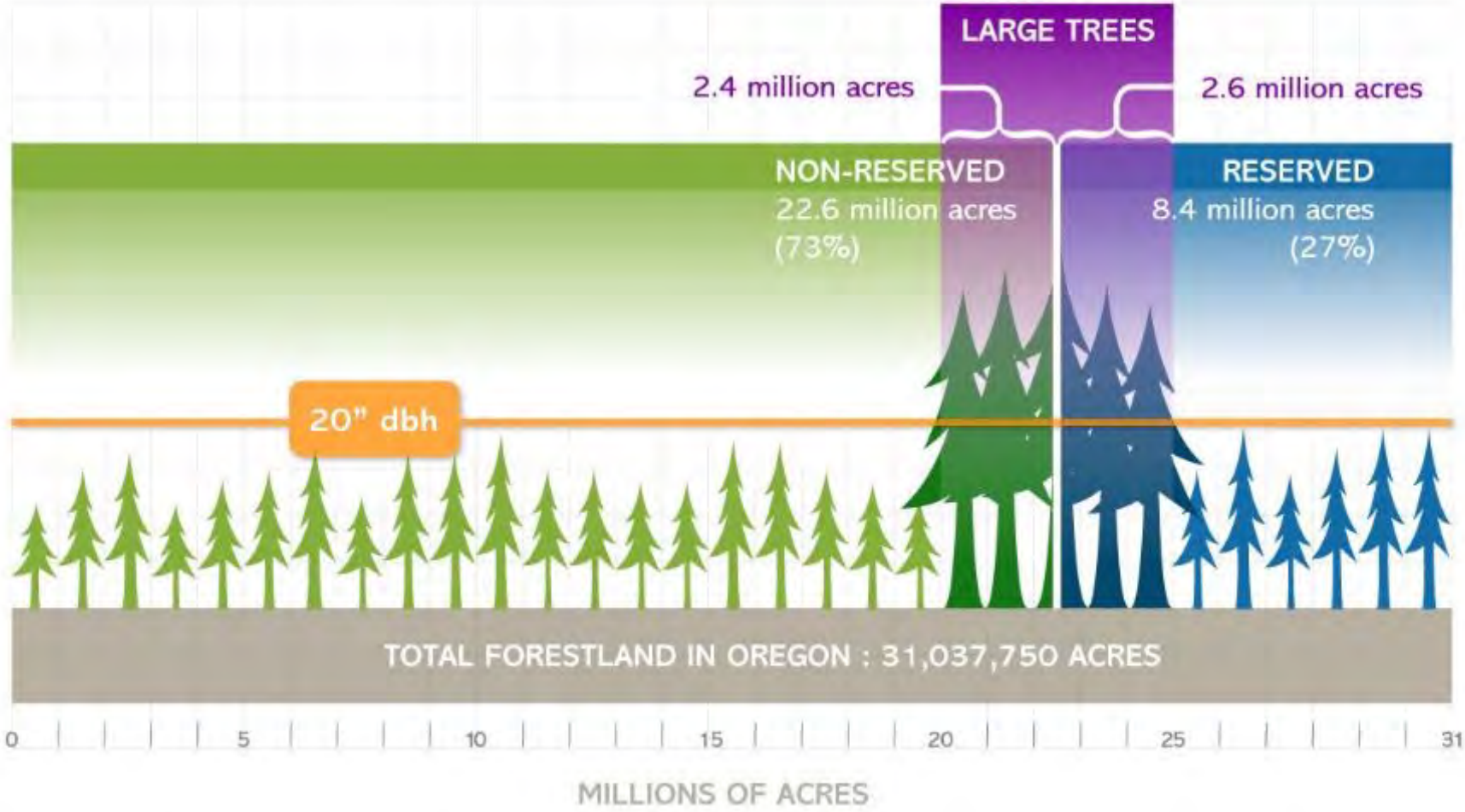

MEC
MEC
HEAD OFFICE

Brock Commons, Vancouver, BC

Mass Timber in the US

Oregon has become the US mass timber hub due to several factors…

OREGON FORESTED AREA - RESERVED LANDS & LARGE TREES



LEADING
LUMBER PRODUCER
IN USA

+76,000 JOBS

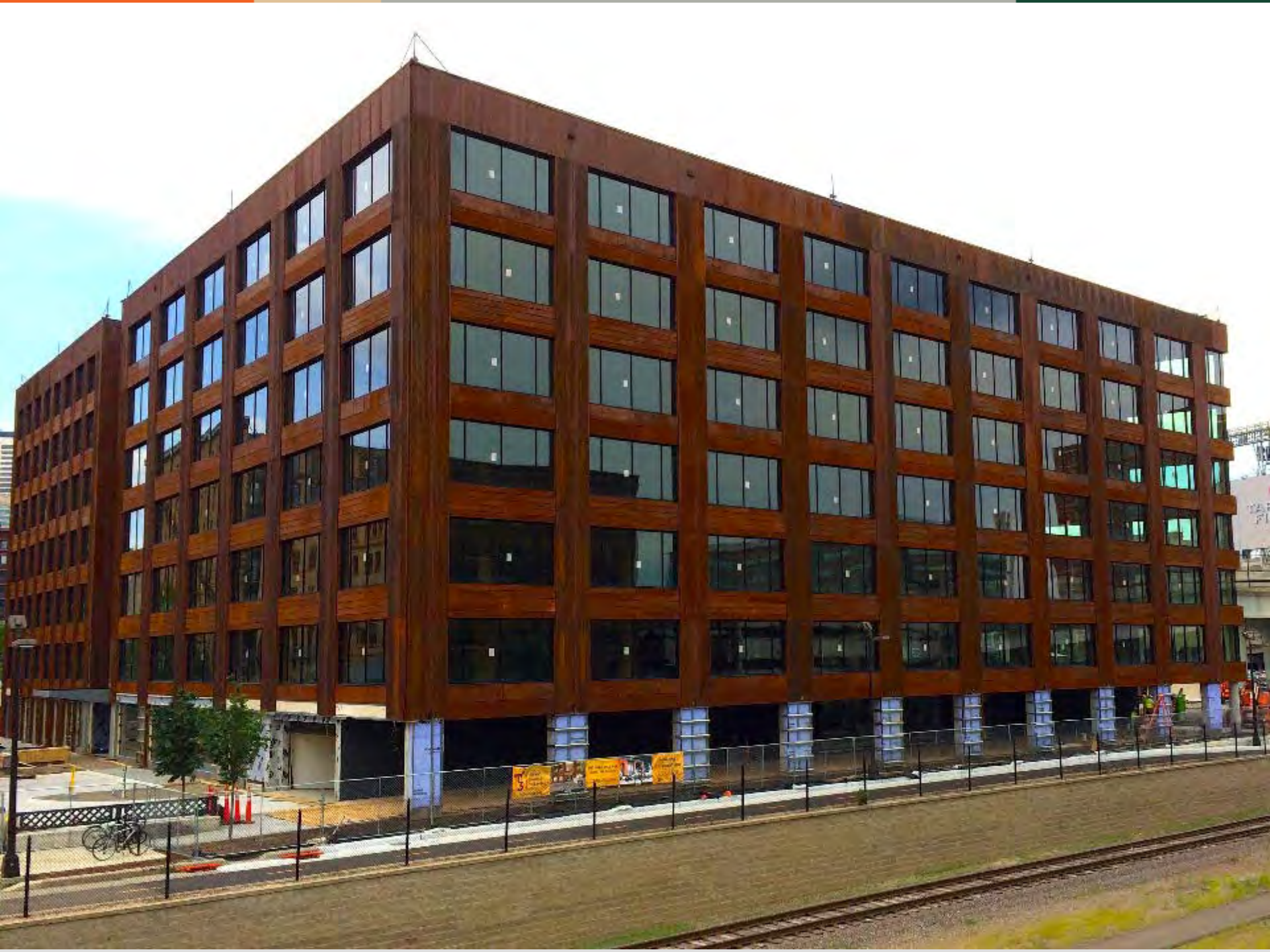
$12.7 BILLION
IN OREGON'S ECONOMY
IN 2011

IN 2011 **NEARLY 16%**
OF TOTAL U.S.
PRODUCTION


Oregon Wood Products Employment, 1950-2014
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Jan-00
Jan-10
Lumber and Wood Products (SIC)
Wood Products, Logging and Adjustments (NAICS)

T3 Building, Minneapolis

Image courtesy of Michael Green Architects



Integrated Design Building, UMass

Barriers to Growth

- Cost uncertainties and lack of familiarity
- Design: seismic, fire, durability (moisture), lack of standardized connector systems, etc.
- Manufacturing: computer aided design skills, computer numerical control fabrication machinery skills, digital integration from screen to machine and jobsite; aversion to capital investment risk; drying capacity
- Construction: different installation skills required than typical general contractors possess

Barriers to Growth

- Cost uncertainties and lack of familiarity
- Design: seismic, fire, durability (moisture), lack of standardized connector systems, etc.
- Manufacturing: computer aided design skills, computer numerical control fabrication machinery skills, digital integration from screen to machine and jobsite; aversion to capital investment risk; drying capacity
- Construction: different installation skills required than typical general contractors possess

These span across disciplines and must be addressed through a coordinated approach

TallWood Design Institute - response

- Industry-focused applied research
- Product development and testing
- Training and education

Oregon State University OSU

TALLWOOD DESIGN INSTITUTE

University of Oregon

Seismic-resilient Design

Redstone Arsenal, Huntsville, AL

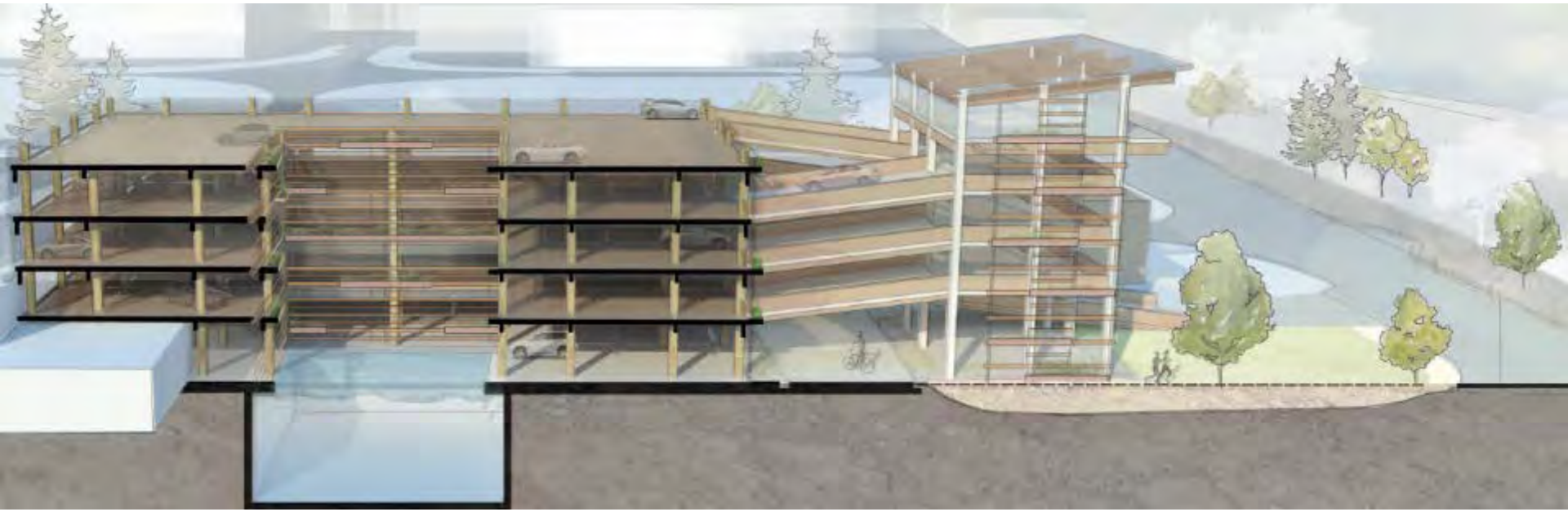
TRANSPARENCE-V

Matthew Decker| Emily Rist| Keith Trine
Judith Sheine, Mark Donofrio, Faculty Advisors

Oregon State University OSU

TALLWOOD DESIGN INSTITUTE

UNIVERSITY OF OREGON



MOMENTUM

Danae Burck | Kelly Elmore | Cara Mitchell | Stefanie Wibiasa
Judith Sheine, Mark Donofrio, Faculty Advisors

KAITO [box-kite]

Tom Adamson | Ryan Kiesler | Tom Moss
Judith Sheine, Mark Donofrio, Faculty Advisors

Oregon State UNIVERSITY OSU

TALLWOOD DESIGN INSTITUTE

UNIVERSITY OF OREGON

HISTORIC HAYWARD FIELD

MASS TIMBER WEST GRANDSTANDS

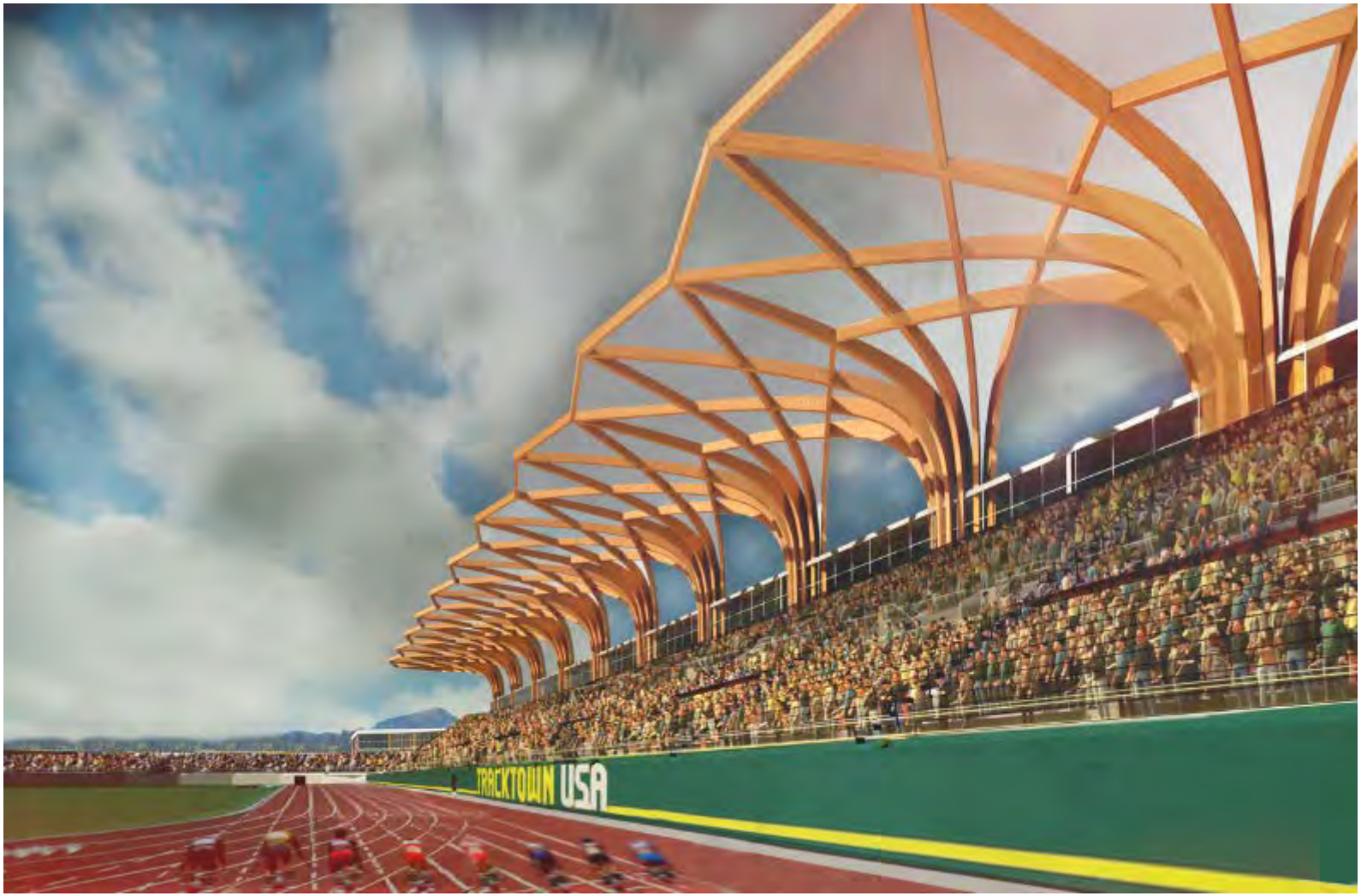
Judith Sheine
Department of Architecture
University of Oregon

Mikhail Gershfeld
Dept. of Civil Engineering
California State Polytechnic
University, Pomona

Oregon State University OSU

TALLWOOD DESIGN INSTITUTE

UNIVERSITY OF OREGON



Hayward Field
SHELL

Jenny Lam| Alexandra Lau | Joshua Tully
Judith Sheine, Mikhail Gershfeld, Faculty Advisors

Hayward Field
WAVY CANTILEVER

David Moreno| Russell Regulinski| Tim Sieroslawski
Judith Sheine, Mikhail Gershfeld, Faculty Advisors

Oregon State University OSU

TALLWOOD DESIGN INSTITUTE

UNIVERSITY OF OREGON

Hayward Field
ARCH

Nicole Giustino | August Lehnert | Max Moore
Judith Sheine, Mikhail Gershfeld, Faculty Advisors

Oregon State University OSU

TALLWOOD DESIGN INSTITUTE

UNIVERSITY OF OREGON


MPP

Mass timber in the USA: the future?

tallwoodinstitute.org
@tallwooddesign

Oregon State UNIVERSITY OSU

UNIVERSITY OF OREGON