New England's Forest Industry Opportunities

Keynote Presented at the NEFF 2024 Annual Meeting

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ASCC

- Largest Univ.-based research Center in Maine
- Founded through the NSF in 1996
- 2,900+ students funded from 35 majors
- Over 400 Personnel
- 100,000 ft² lab
- 10+ spinoff companies
- 1,000 publications
- 130+ patents
- 30,000 Visitors
- 1,600 media stories

Awards & Honors

Over 40 state, national and international excellence awards

2015 Transportation Champion of Change

MAINE TRANSPORTATION ACHIEVEMENT AWARDS

2019 Transportation Champion

Windpower ENGINEERING & DEVELOPMENT

Innovator 2017

Three 2019 Guinness World Records

mitc Maine International Trade Center

2017 Innovator of the Year

ENR Engineering News-Record

2016 Top 25 Newsmakers

ACEC
AMERICAN COUNCIL OF ENGINEERING COMPANIES

2011 Engineering Excellence

MAINE DEVELOPMENT FOUNDATION

2008 “Champion of Economic Development”

ACMA
American Composites Manufacturers Association

2021 Academic Pioneer Award
2010 Most Creative Product
2007 People’s Choice
2007 Best of Show

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

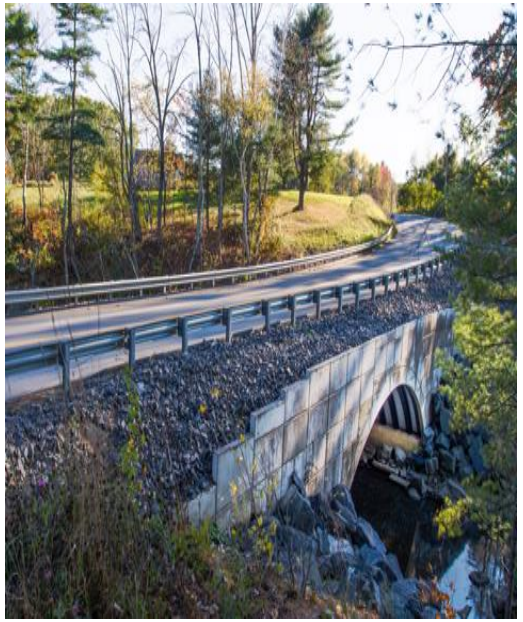
2011 Charles Pankow Award for Innovation

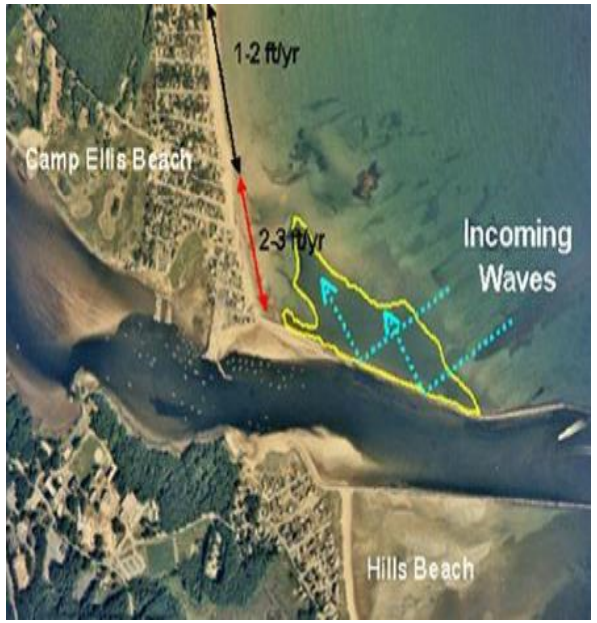
ASCC Partners and Clients

THE UNIVERSITY OF MAINE

GEM - *Green Energy and Materials*

Developing the Technologies and Educating the Leaders





Application Space

Civil Infrastructure, Renewable Energy, Defense, Marine and Aerospace

Bridge Design and Testing

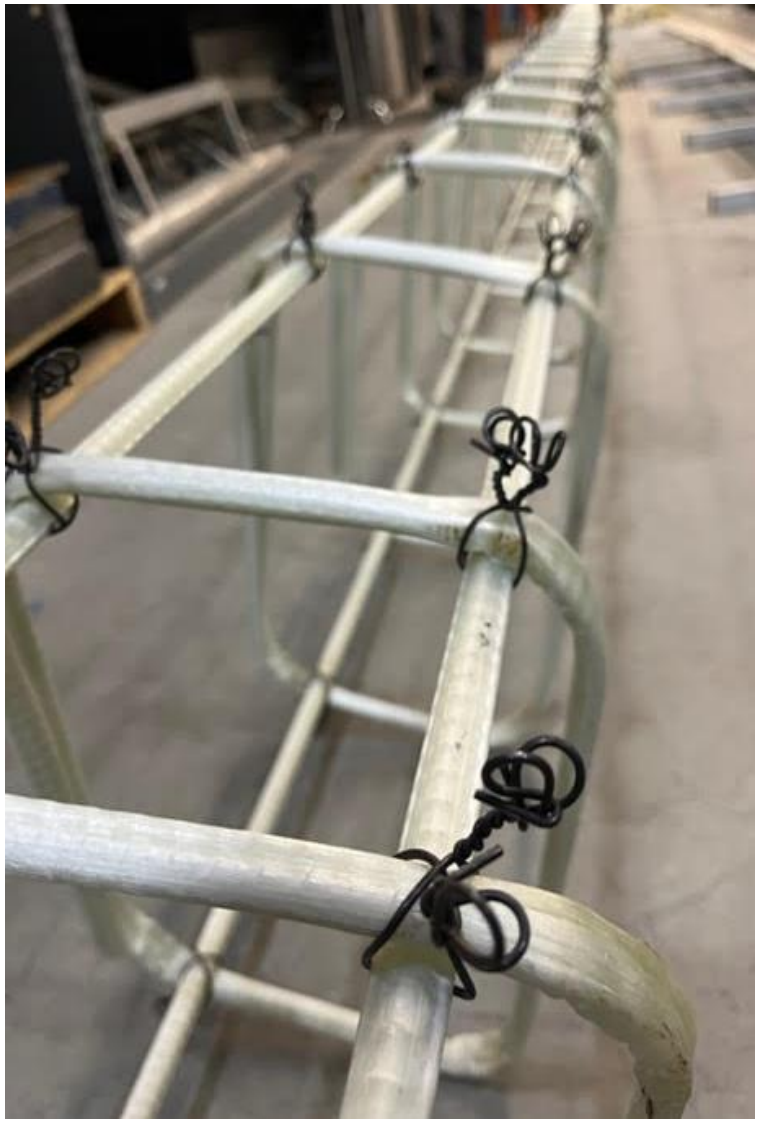
THE UNIVERSITY OF MAINE

ADVANCED STRUCTURES & composites center

ADVANCED INFRASTRUCTURE TECHNOLOGIES

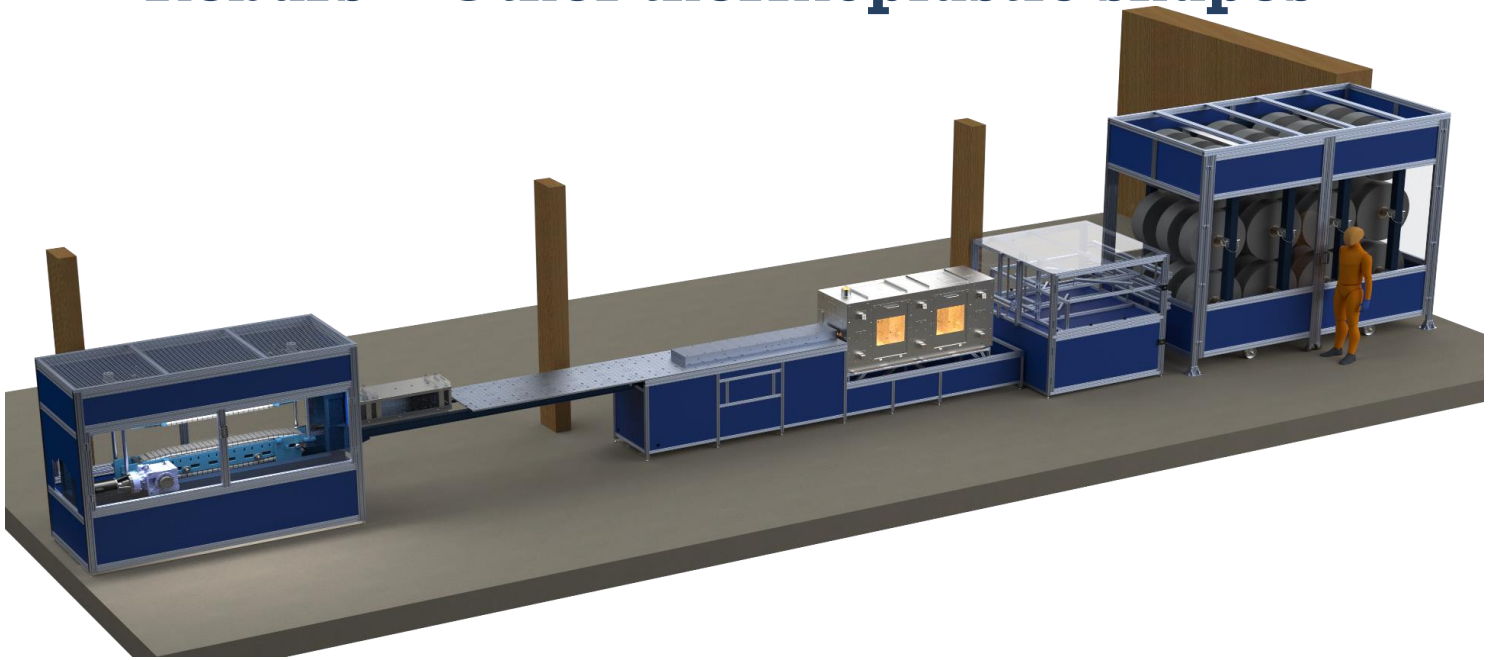
Penobscot Narrows Bridge

- Some steel strands replaced with carbon composite strands



CONTINUOUS FORMING MACHINE (CFM):

Rebars + Other thermoplastic shapes



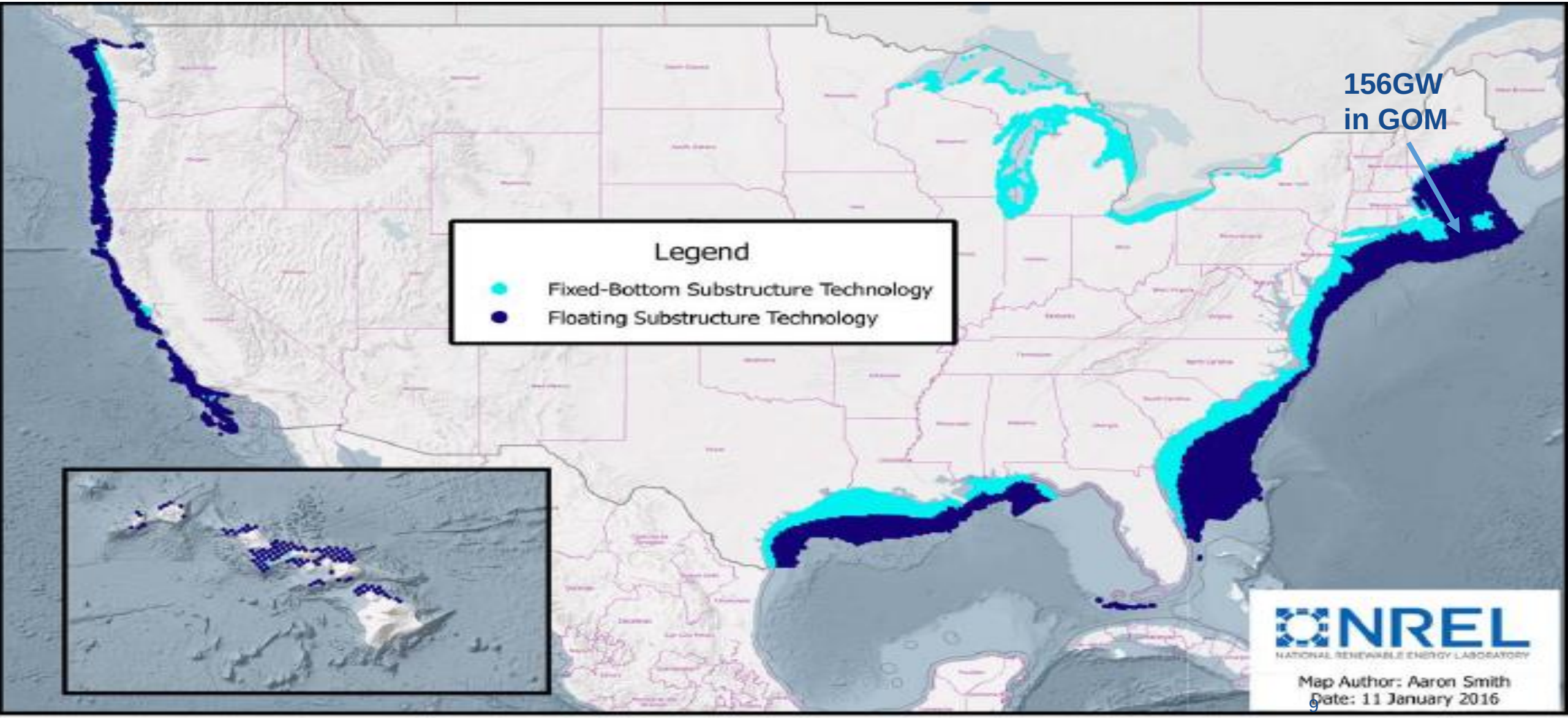
REBAR:

- 12 ft/min
- Twice strength of steel, while reducing weight and corrosion.
- Field bendable without special tooling.
- Recyclable.

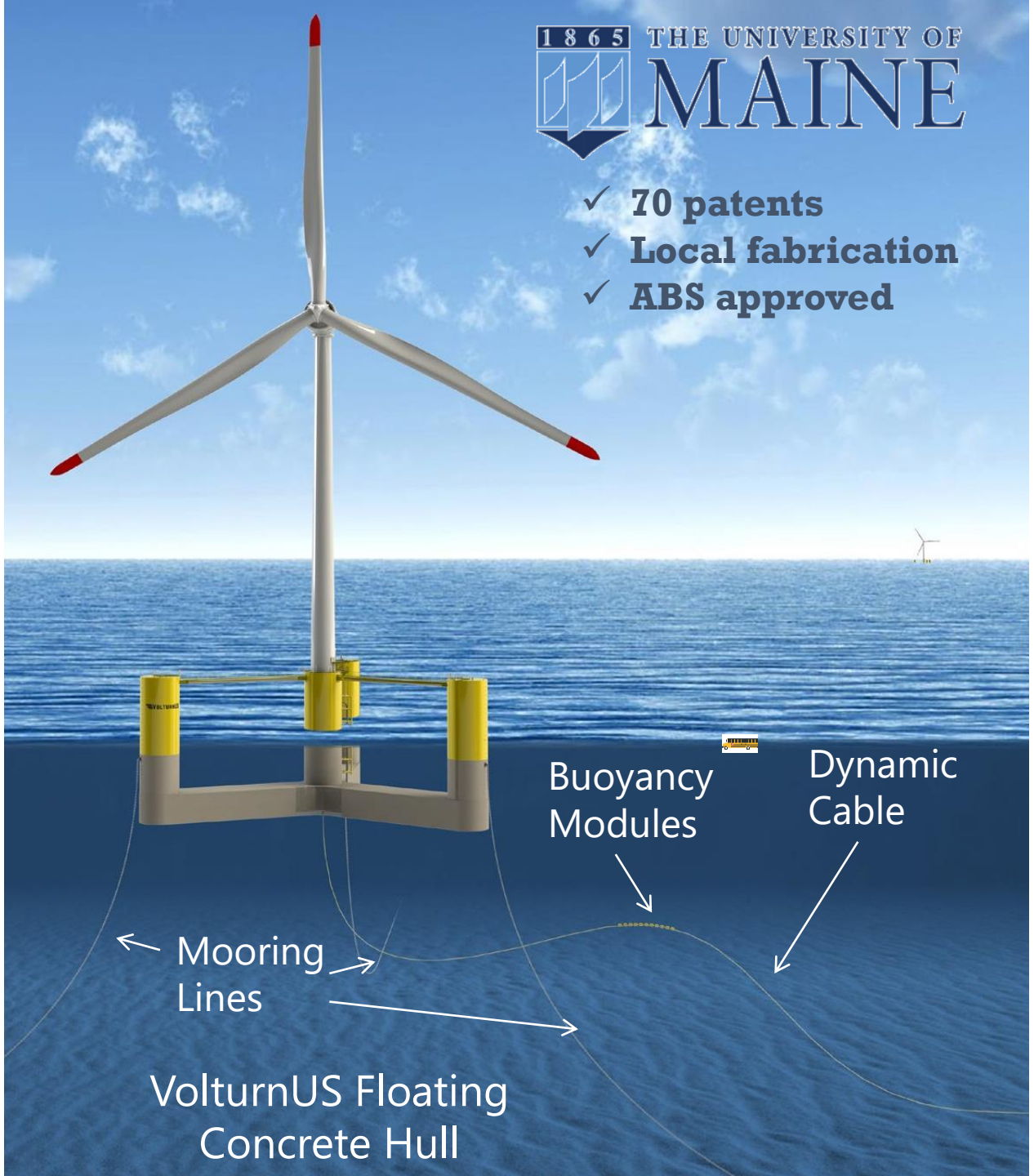
US Potential for Floating Wind

60% of US resource requires floating technology US Earth Shot

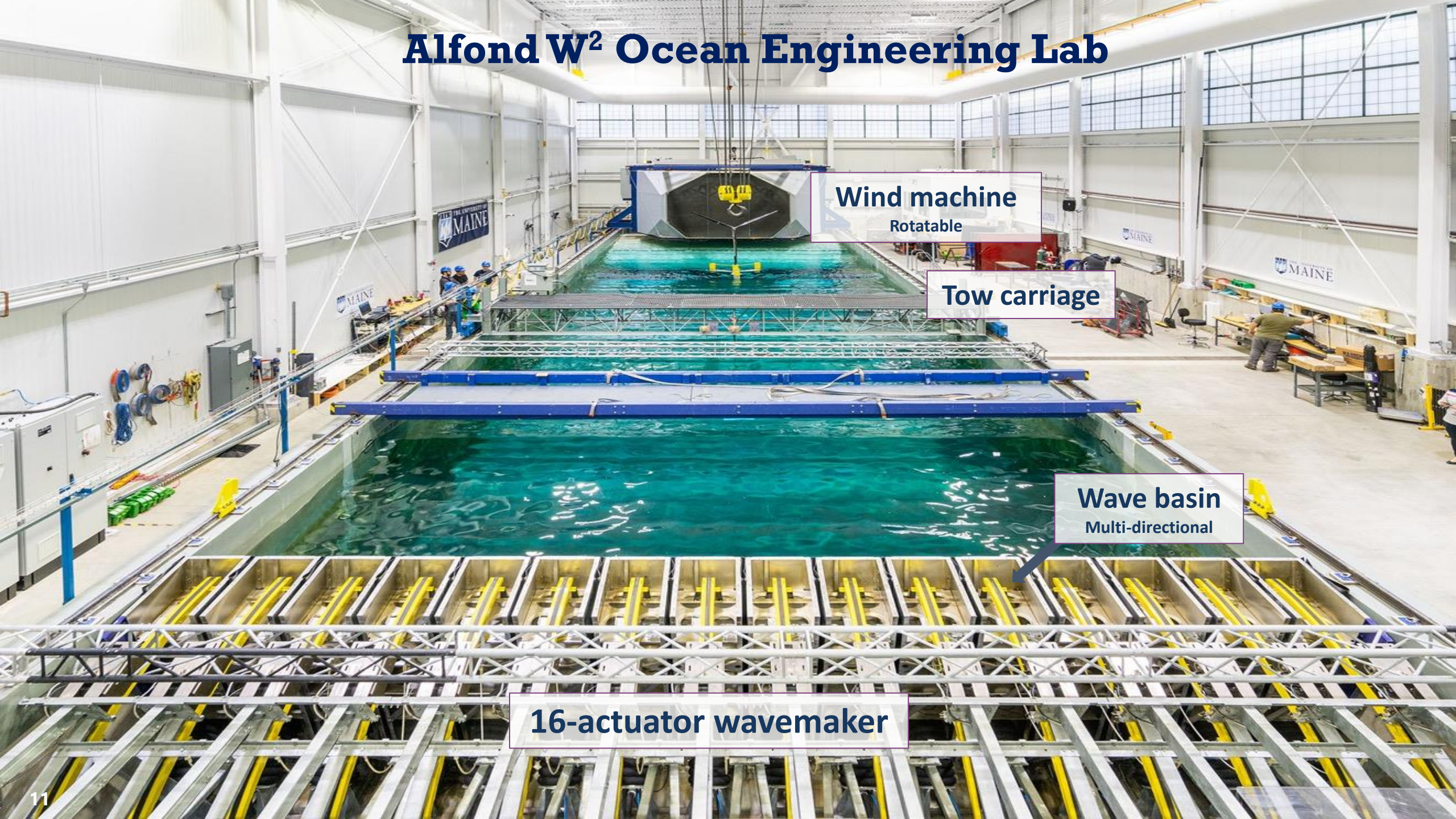
BOEM awarded CA leases: GOM next



Floating Offshore Wind



Alfond W² Ocean Engineering Lab



6. Additive Manufacturing Opportunities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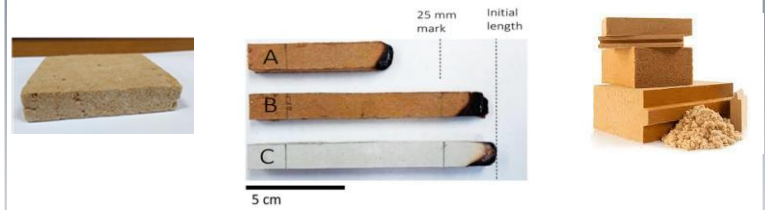
Additive Manufacturing Opportunities

New World's Largest Polymer 3D Printer

Building Technology Research
Scalable Sustainable Affordable Housing

Materials Innovations

Biobased Insulation, Wall Board, and Gypsum Replacement



Biobased Additive Manufacturing Feedstock

Manufacturing Innovations

- Automated Feedback for Process Improvement
- Large Scale Additive
- Selective Subtractive
- Automated Fiber Placement
- Pick and Place
  - Flowable Media: Insulation
  - Flexible Media: Plumbing/ Conduit
  - Solid Elements: Fenestration/ Fixtures

Integration Innovations

Modular Volumetric

Modular Panelized

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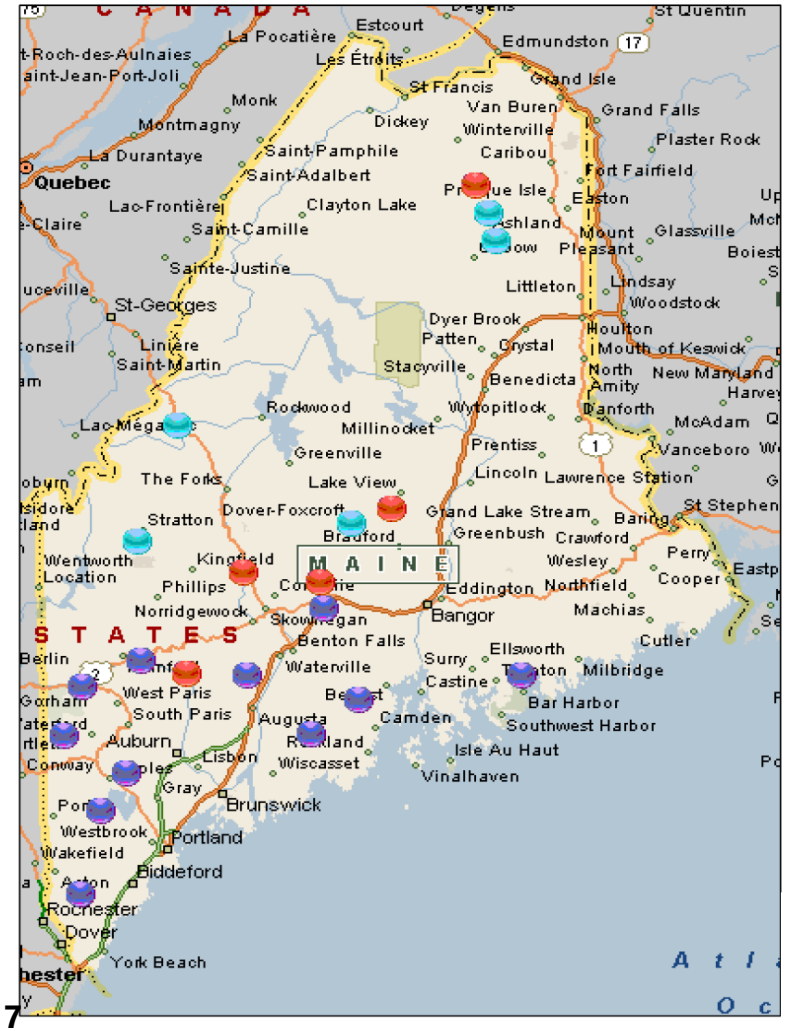
Can we Use Wood Residuals to Print Homes?

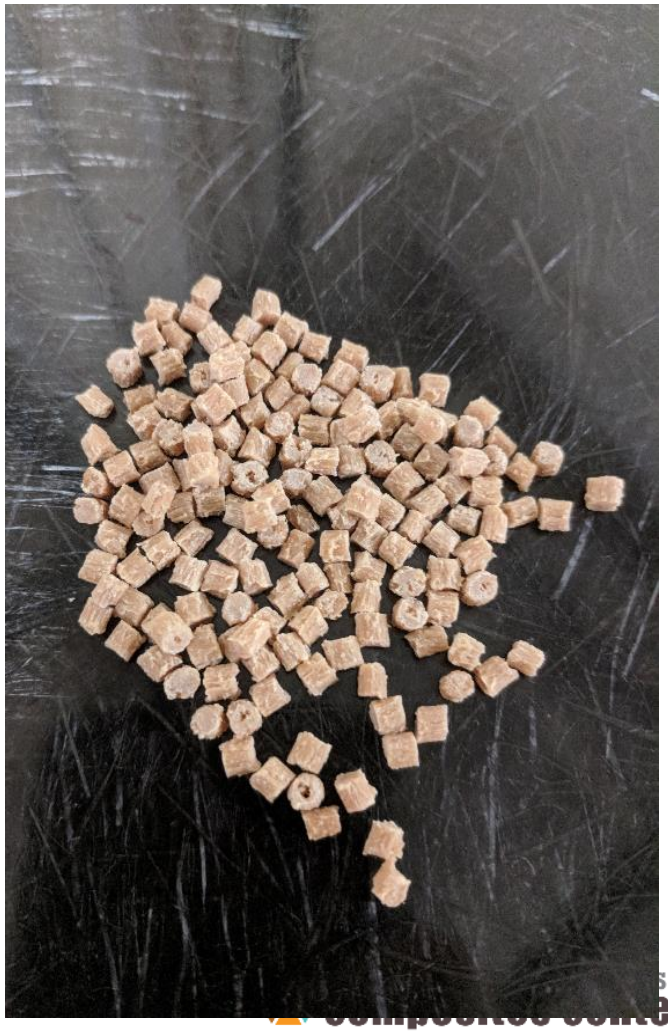
1 million tons/year

600ft² home needs 10 tons

Sawmills Residues



Stronger than Concrete



Printing a module using wood and a bio-resin

Floors, roof and walls are all 3D printed.

Printing a module using wood and a bio-resin

Floors, roof and walls are all 3D printed.

First module installed on Foundation

First module installed on Foundation

Demonstration: BioHome3D
World's first 100% Biobased 3D Printed House

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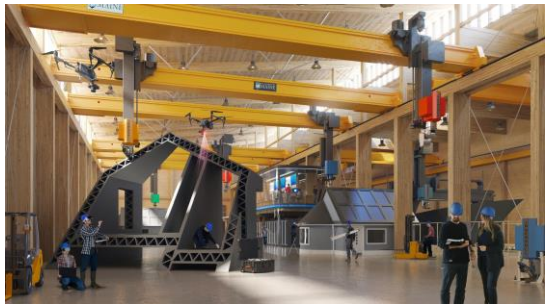
BioHome3D Going Through "A Good Old Maine Winter"

Technology Roadmap for Biobased Modular 3D Printed Homes



2022
150lb/hr
100% biobased feedstock

2023
500lb/hr
Integrated chases, R-value

2024
FoF 1.0
Flame retardant chemistry

2025
Scale up feedstock with flame retardant

2026
Factory of the Future

BioHome3D 2.0

9 Units Penquis

25

What's Next:
A 3D Printed Neighborhood For the Homeless

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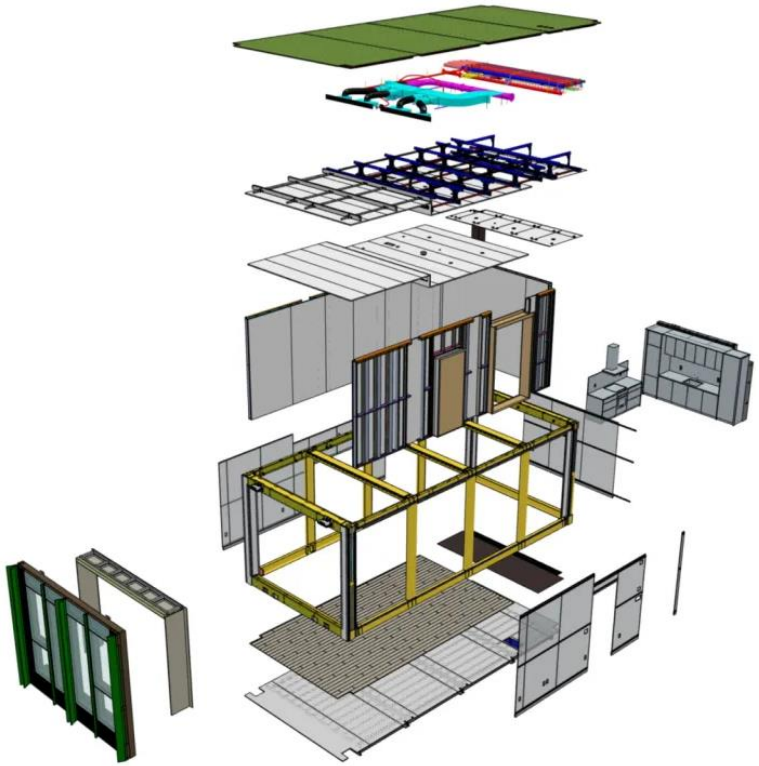
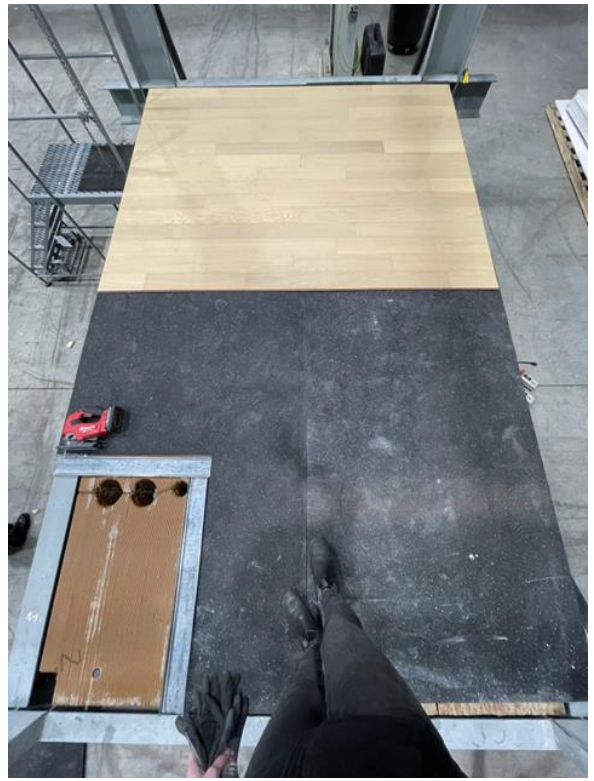
Demonstration: Additively Manufactured Floor Cassette
100% Biobased 3D Printed Modular Component
Modular Panelized Systems Integration





Factory of the Future
An Array of AI-enabled Hybrid Manufacturing

Sustainable Mass Timber Building Flagship LEED Platinum sustainable building uses mass timber, solar heating and PV panels and electric car charging.

AI-Enabled Additive Manufacturing
Multiple 3D printers AI-enabled by high-performance computers and sensors providing feedback to produce "born-certified" parts

The Building is the Printer
Multiple print-heads, machining heads, Tape layup heads on overhead cranes provide print flexibility and full-scale production line for structures up to 200' long, 60ft wide and 25 ft high

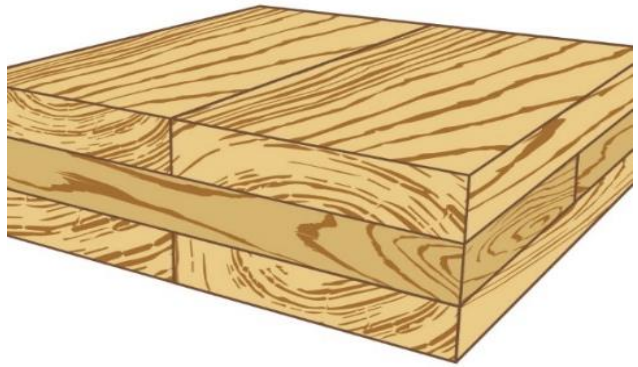
Autonomous Quality Inspections
Drone-based inspections provide real-time data to printers to provide quality control, print optimization and AI-enabled self-adaptation

High-Performance Computing
Fully-digitized, adaptive factory relies on computational methods and tools including optical-based analytics, augmented reality, real-time monitoring, digital twin, which rely on the HPC "brain"

Focus on Large Components
Printing homes, schools, boats, bridges, vehicles and even furniture, using wood resources

Bio-Based & Recyclable Materials
Material formulations optimize use of locally-produced nanocellulose and recycled plastic feedstock

2. CLT



The Case for CLT Manufacturing In Maine

MAINE MASS TIMBER Commercialization Center

Maine and its vast forest sit atop one of the largest population centers on the planet, making it an ideal location to produce mass timber products to feed the growing urban demand for timber housing.

Objectives

- **Bring together** state and regional stakeholders to demonstrate Maine's support of these mass timber technologies
- **Answer questions** that mass timber manufacturers & investors have regarding Maine's forest products economy
- **Conduct R&D** to support increased use of (Maine-made) mass timber
- **Be at the forefront** of regional mass timber promotion

MMTCC

Maine Mass Timber Commercialization Center includes **40** *(and growing)* regional manufacturers, sawmills, landowners, architects, engineers, code officials, and trade associations

Maine's forest economy growth target

2025 $12BN

2018 $8.5BN Current Industry

Opportunity for 40% growth

Source: 2018 FSR/Maine report

DID YOU KNOW?

UMaine sits on the PRG-320 Committee and is ISO 17025 accredited to test CLT under this standard

Proximity to Market

Recent CLT Research at UMaine

- Two new grades of CLT using local SPF-S
- Qualification testing of Eastern hemlock CLT
- Bond Durability of CLT using 7 Northeastern species
- Hybrid SPF-S / LSL (softwood/hardwood)
- CLT with gaps
- Blast resistant CLT buildings (Woodworks)
- Thermally insulated CLT using wood fiber

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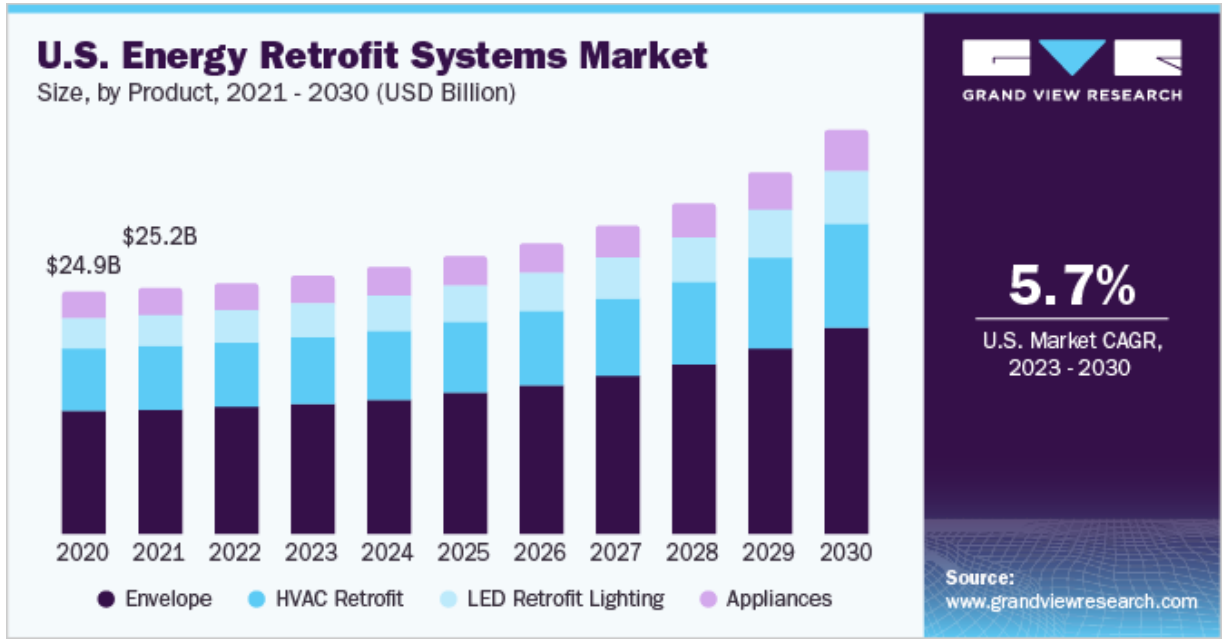
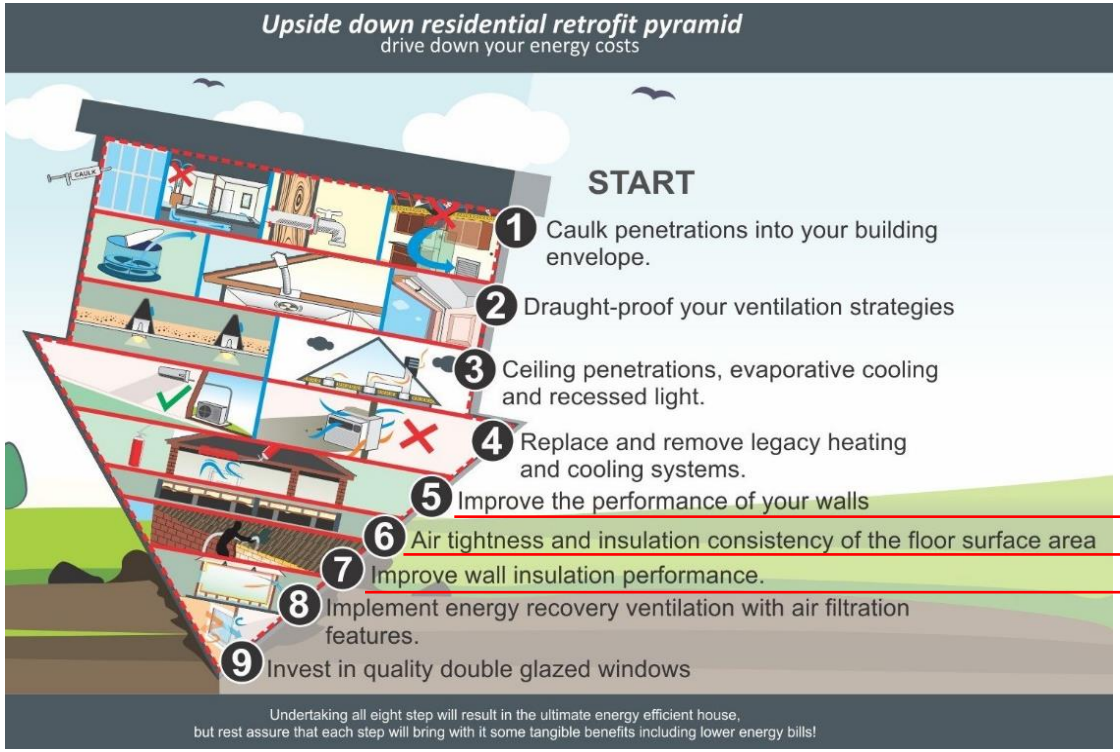
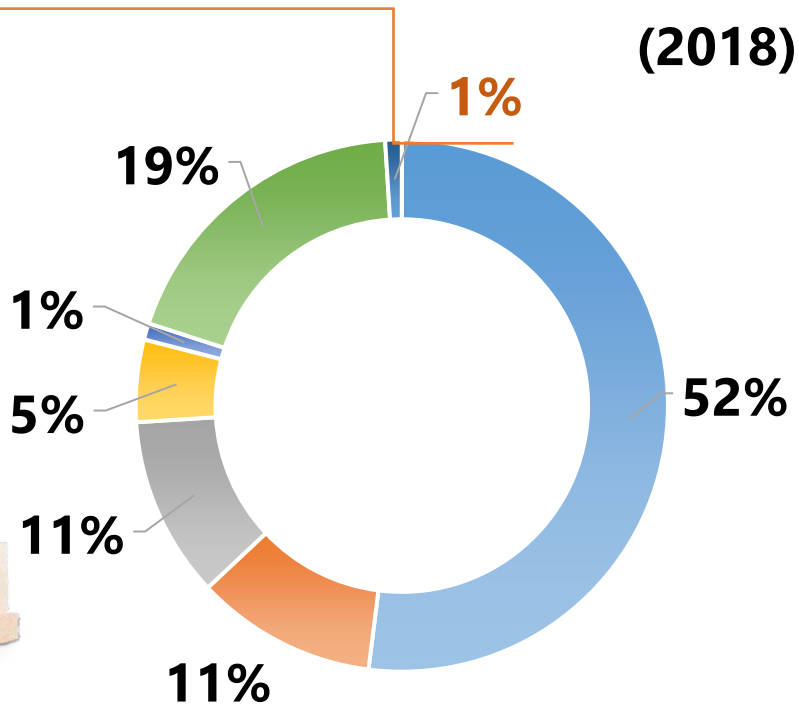
3. Energy retrofit/ Wood Fiber Insulation





https://efficiencymatrix.com/upside-residential-energy-efficiency-retrofit/

5. WOOD FIBER INSULATION



WOOD FIBER INSULATION (WFI)

- Renewable, sustainable, carbon neutral
- Biodegradable/Recyclable
- Low embodied energy
- Competitive R-value
- Cost competitive
- Supports local Maine industry as an outstanding outlet for mill residuals

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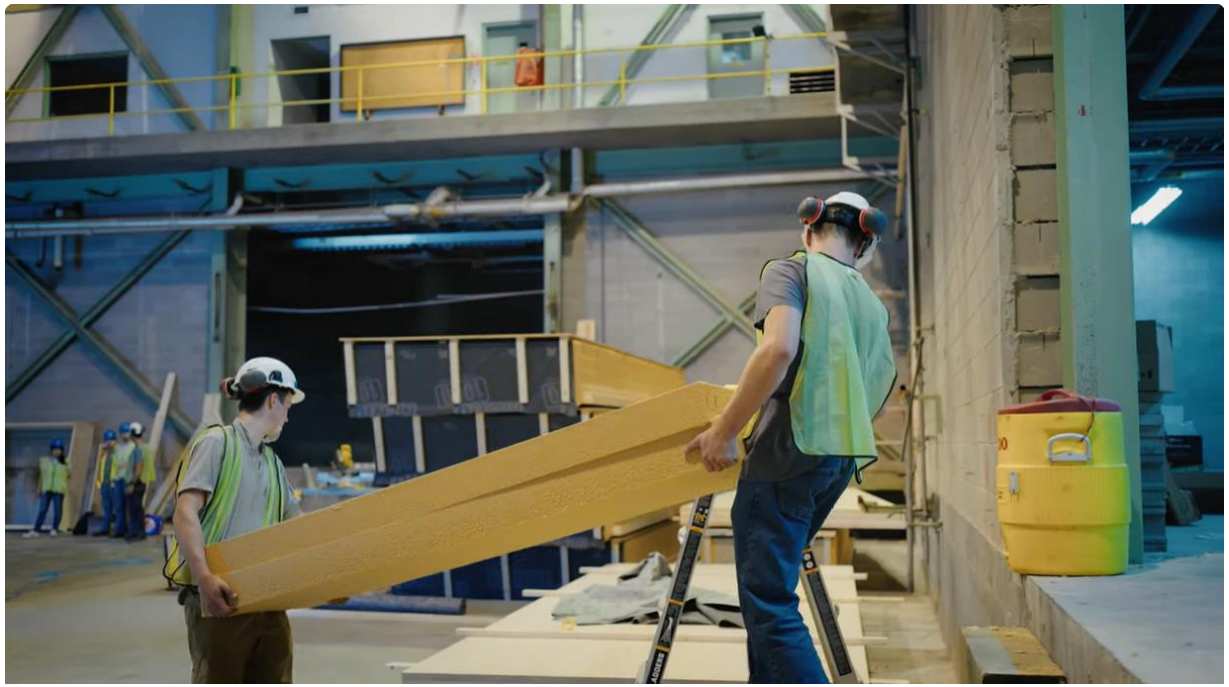
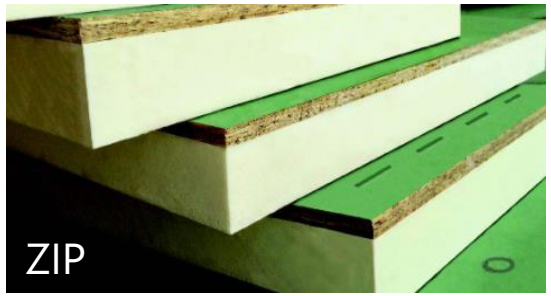
CLT/WFI Building Monitoring

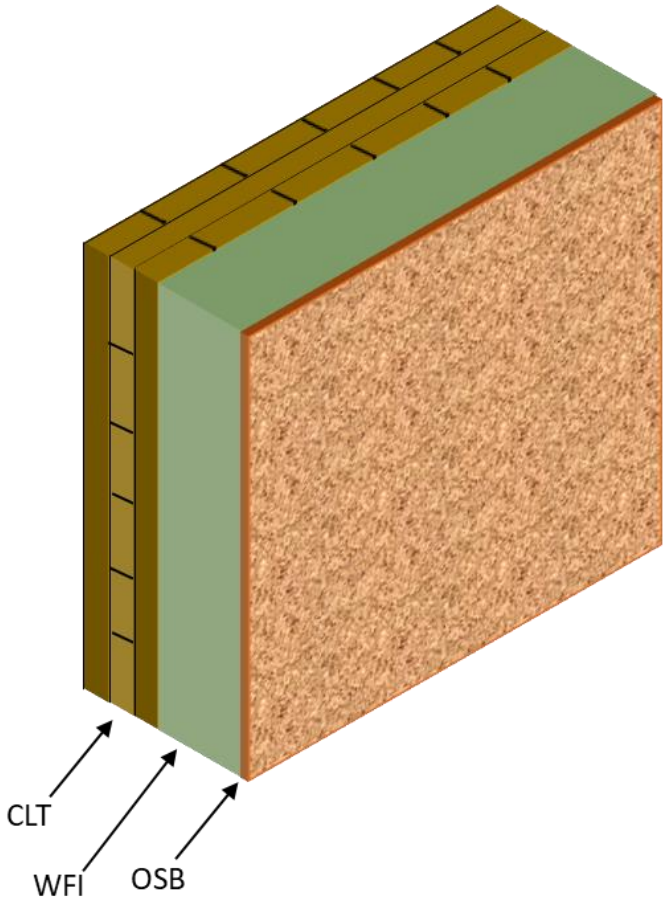
Field study: Hygrothermal and energy performance of a school building made of CLT insulated with WFI

Cornerspring Montessori School at Belfast, ME (Built in summer 2021)

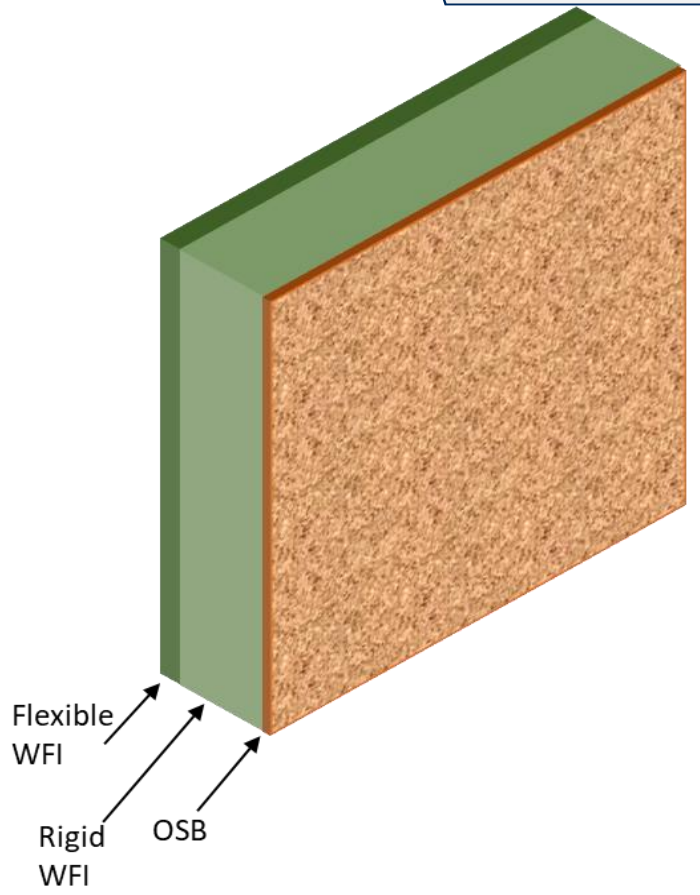


CLT Building Construction from start to finish by OPAL Architecture





New construction



Retrofit

SM²ART Research Thrust Areas

Cellulose nanofiber production
- Reduction of water and energy usage
- Surface treatments
- Drying and dewatering methods
- Fibrillation processes

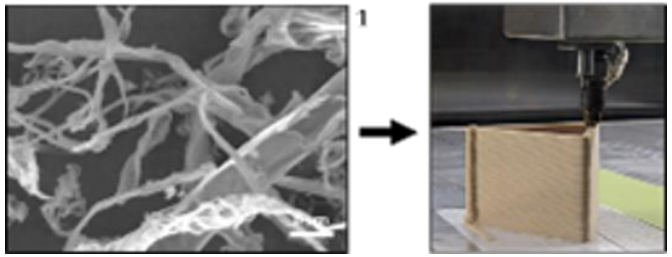
CNF modeling and simulations
- Application of high-performance computing and molecular dynamics simulations to predict CNF morphology and dispersion

Material formulation and process development
- Development of hybrid bio-composites for AM feedstock
- Optimizing rheological and thermal properties for AM

Composite innovation
- Integration of CNFs into polymer matrices
- Replacing petroleum sources with renewable biomass
- Achieving desired mechanical performance

High throughput, low cost AM
- Development of high-throughput extruder (500 lbs/hr)
- In-process qualification using multivariate sensors
- Causal modeling to close AM feedback loop

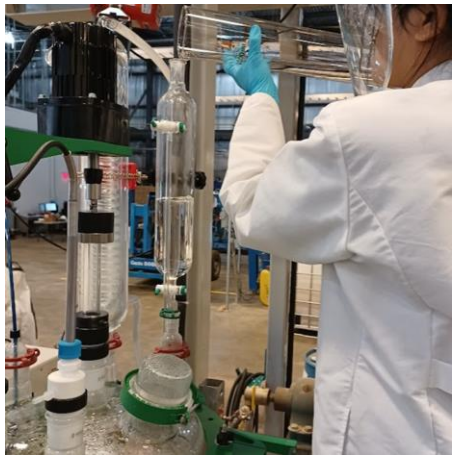
Biocomposite applications and sustainability
- Structural applications (housing marine, etc.)
- Lightweight bio-foams
- Molding and tooling applications
- Recyclability of CNF thermoplastic composites



CNF reinforced bio-composite AM feedstock

Capabilities

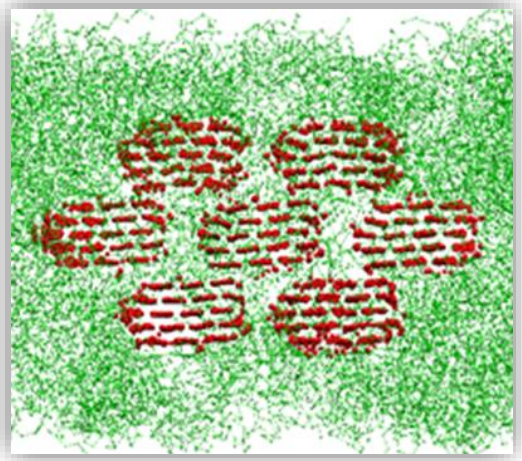
Chemistry and materials development



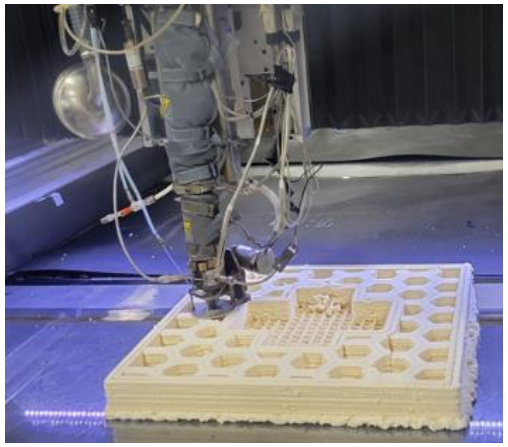
Composite innovation

Nanocellulose

Simulations



Process innovation



Characterization and analysis

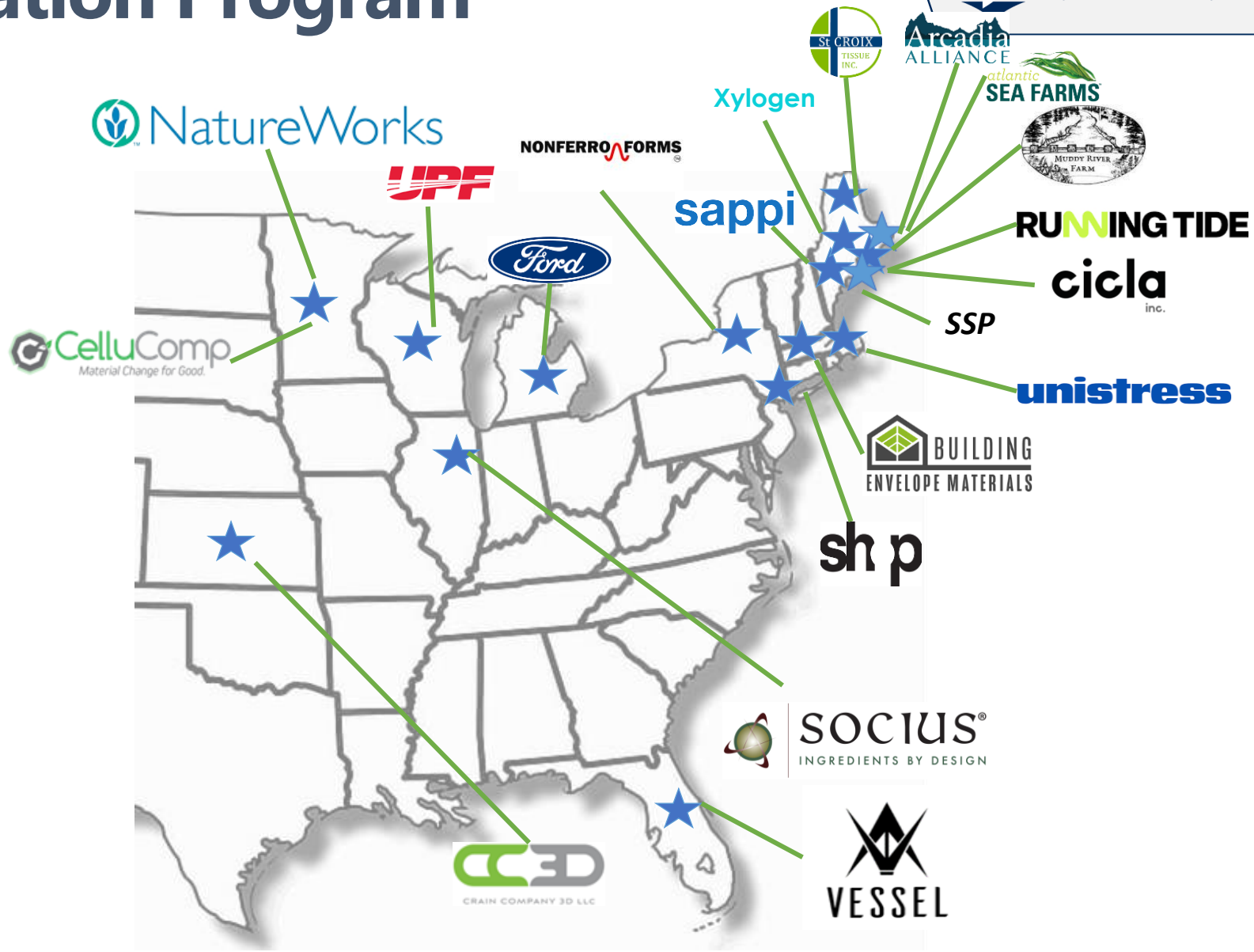
Multidisciplinary expertise

Prototyping and direct fabrication

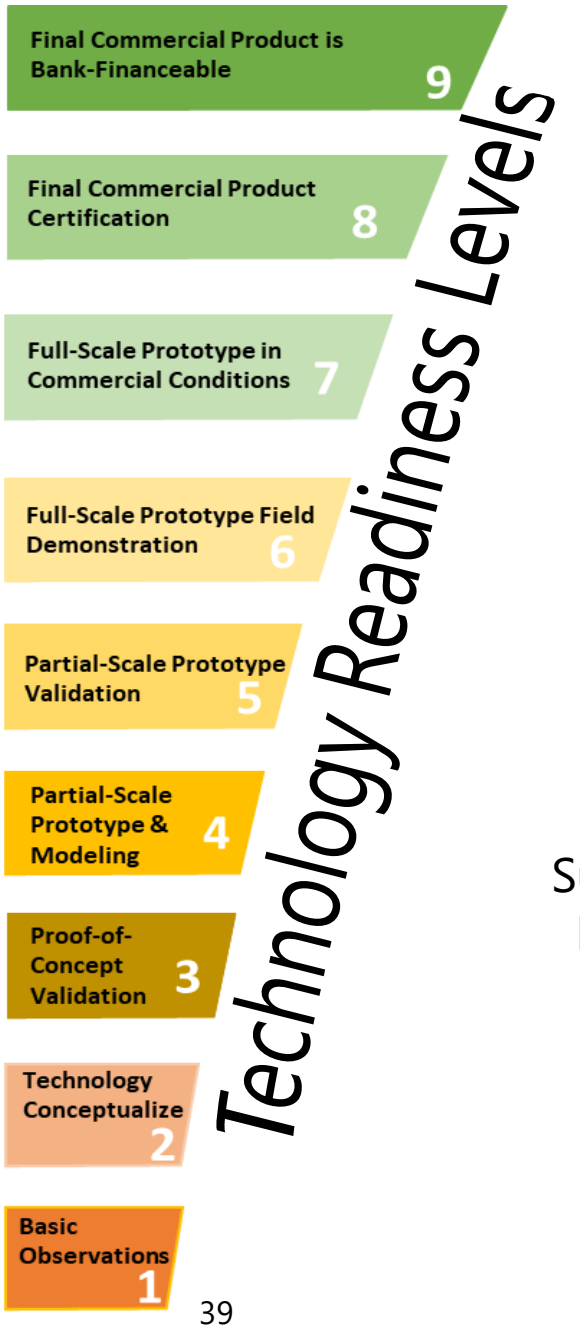
Technical Collaboration Program

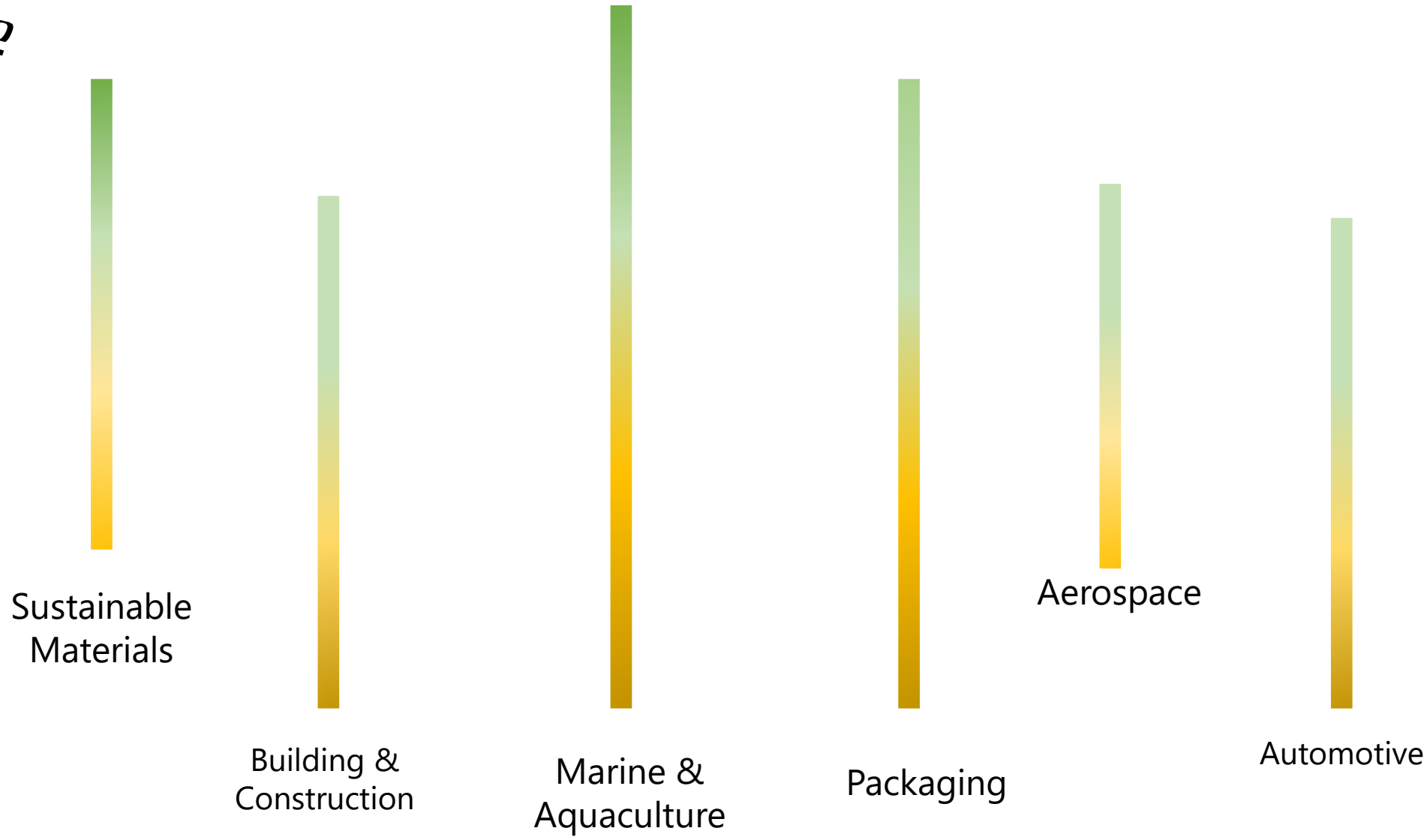
Value to partners and ecosystem

- First customer connections
- Creating **"market pull"** for biobased materials
- Identifying high volume opportunities for cellulose nanofibrils, wood residuals, and large area additive manufacturing



Applications TRL Overview





Industry Technology Collaborations

Explore	Engage	Execute
• Opportunity for industry to discover and apply new manufacturing technologies	• Work with manufacturing staff to develop scope of work	• Phase 1 $40K Phase 2 $200K • 1:1 In Kind Contribution

Bio-based Materials, Buildings, Packaging, Automotive, Marine, Off-Shore Wind Energy

- Through the SM^{2}ART program, US industry can access the facilities and expertise of the MDF at ORNL and/or UMaine by submitting proposals aligned with the core themes of the sustainable composite manufacturing project.
- Selected proposals for "tech collaborations" will result in short-term, cost-shared projects.
  - Phase I: $80K with DOE providing $40K and industry providing min. $40K
  - Phase II, if Phase I shows exceptional promise: $400K with DOE providing $200K and industry providing min. $200K

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A special thank you to the team who conceptualized, designed, printed and constructed BIO 3D


James Anderson


Matthew Ayotte


Wesley Bisson


Hilary Buntrock


Angelina Buzzelli


Giovanni Calcagno


Tyler Chase


Katherine Clukey


Alexander Cole


Matthew Cowing

Seth Dixon


Bryan Doucette


Shawn Eary


Russell Edgar


Carson Fiscus


Andrew Foster


Richard Fredericks


Samuel Furth


Douglas Gardner


Andrew Gifford


Evan Gilman

Zack Guay


Oliver Hafford


Benjamin Herzog


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Melissa Kelly


Kelsey Kunich


Audrey Laffely

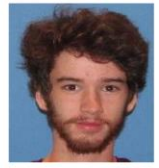

Richard Lafreniere


Claire Liedtka


Susan MacKay


Aaron Madore


Michael McCarty


Caleb Miller


Walter Morris


Sam Morton


Tess Mylander


Jared Palmer

Joshua Pearse


Thomas Perkins


Spencer Sansouci


Camden Sawyer

Camerin Seigars

Emma Sheffield

Lucas Shorette

Gregory Simms

Douglas Slocum

Thomas Snape

Emily Stauffer

Jason Stevens

Kelsey Swan

Quest Teichman

Scott Tomlinson

Christopher Urquhart

Lincoln Varnum

Lu Wang

Justin Willis

Daniel Wortman

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