Carbon Fiber Technology Facility

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U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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Carbon Fiber Technology Facility (CFTF) CAPITAL Project Overview

Timeline

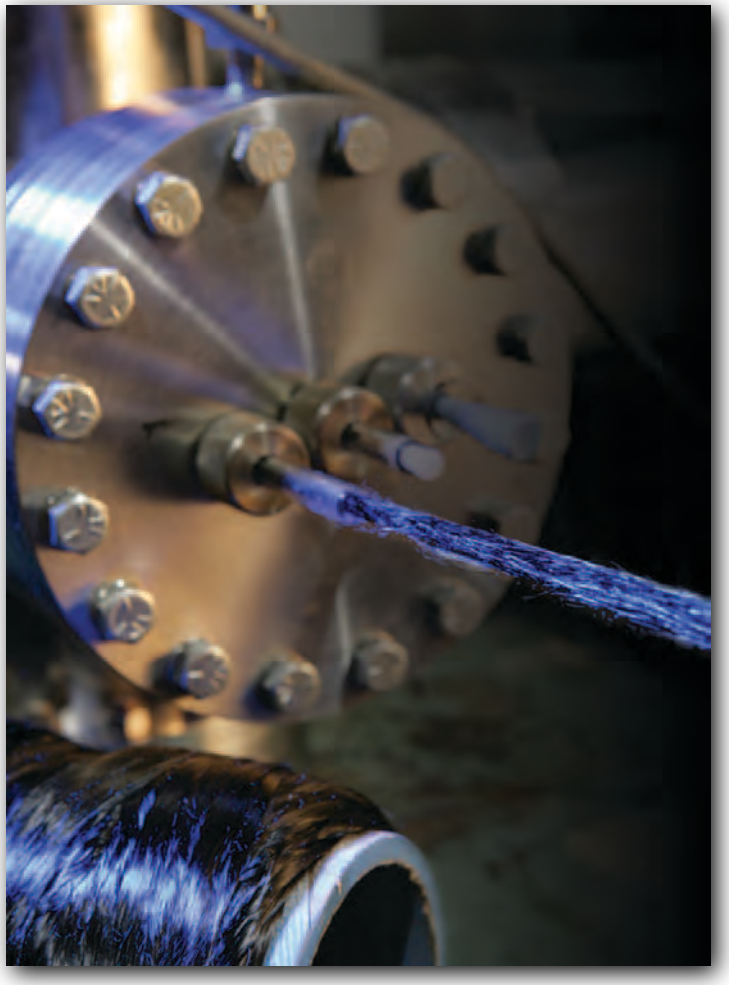
- **Funds received FY10Q2**
- **Scheduled finish FY13Q4**
- **Forecast finish FY13Q2**
- **Currently in design phase**

- **$34.77M Budget**
  - No cost share
- **All funds have been received**

- **Barriers addressed**
  - Cost
  - Inadequate supply base
  - Manufacturability
- **Interactions/ collaborations**
  - Capital project – none
  - Future operation - extensive
- **Project lead - ORNL**

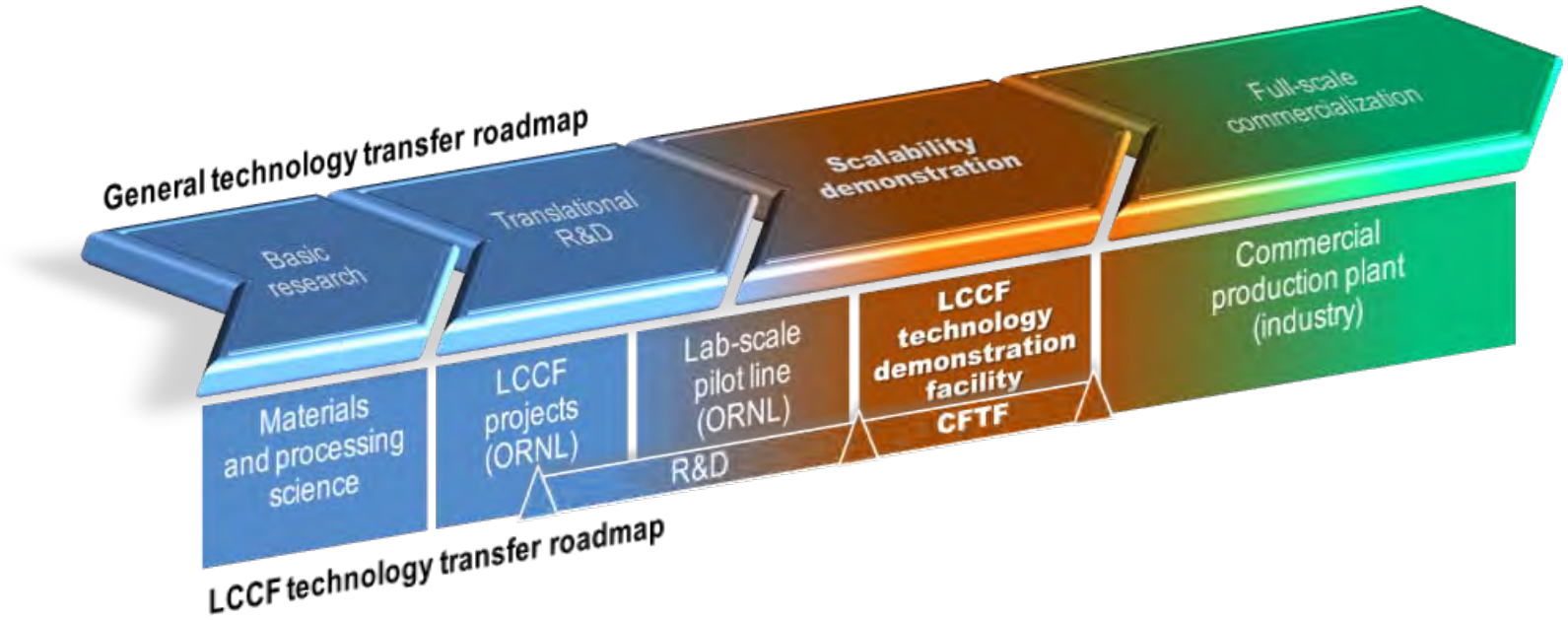
Carbon Fiber Composites Program "Pillars"

- **Develop and demonstrate new carbon fiber precursors**
- **Develop and demonstrate advanced technologies for converting conventional and alternative precursors to carbon fiber**
- **Advance high-volume composite design and manufacturing capabilities**
- ***Transition technology to industry partners***



Fully-carbonized fiber exiting the microwave assisted plasma carbonization unit

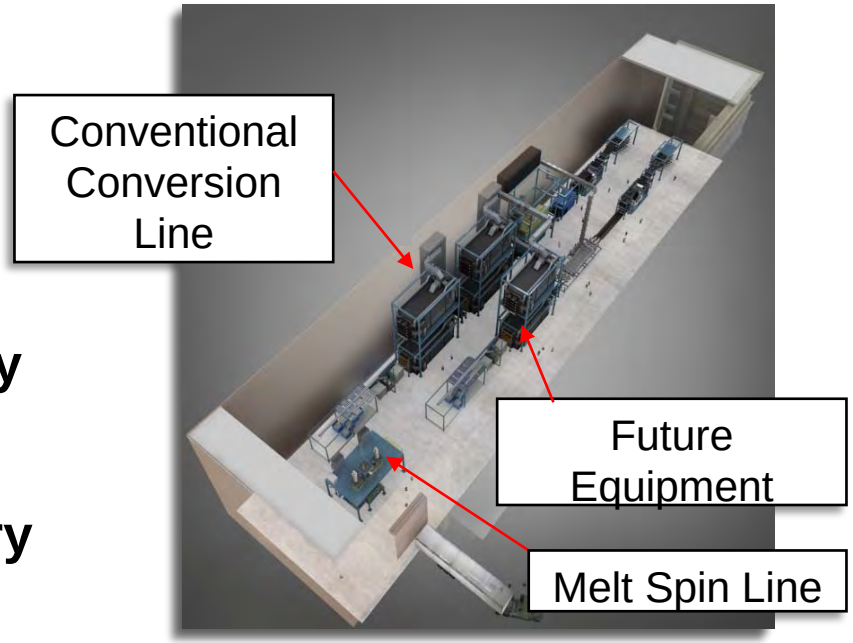
CFTF is the Bridge from R&D to Deployment and Commercialization



- **CFTF will:**
  - **Produce quantities of Low-Cost Carbon Fiber needed for large-scale material and process evaluations / prototyping**
  - **Demonstrate LCCF technology scalability – CFTF is the last scaling step below full-scale commercial production**

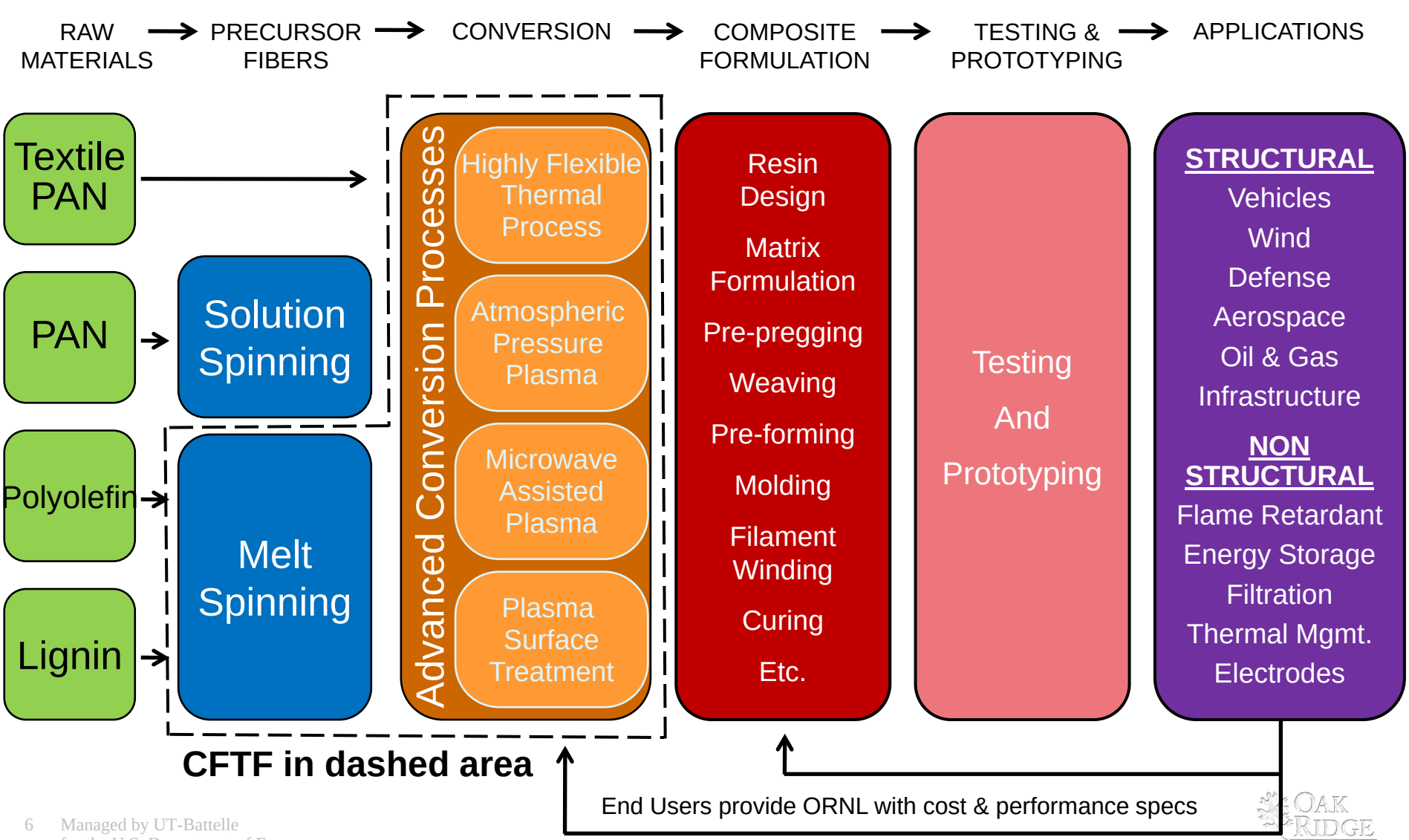
Carbon Fiber Technology Center (CFTF) Snapshot

- **Highly instrumented, highly flexible conventional carbon fiber line for "any precursor in any format"**
- **Melt-spun fiber line to produce precursor fibers**
- **Provisions for additional future equipment**
- **Produce up to 25 tonnes/year of carbon fibers**
- **Demonstrate technology scalability**
- **Train and educate workers**
- **Grow partnerships with US industry**



Facility and equipment perspective

CFTF Engages the Composites Value Chain to Develop/Validate Low-Cost CF Composites Matls & Mfg Technologies & Grow the Supply Base



Approach

- **Technology validation at semi-production scale gives industry the confidence to deploy at full scale**
  - **Melt spun precursor fiber line**
  - **“Conventional” carbon fiber line with unmatched flexibility**
  - **Future – advanced technology carbon fiber line**
- **Validate alternative precursors on conventional carbon fiber line**
- **Validate advanced conversion processes with conventional precursors**
- **Validate combination of alternative precursors and advanced conversion processes**

Approach Requires Technology Validation at Semi-Production Scale

Carbon Fiber Line

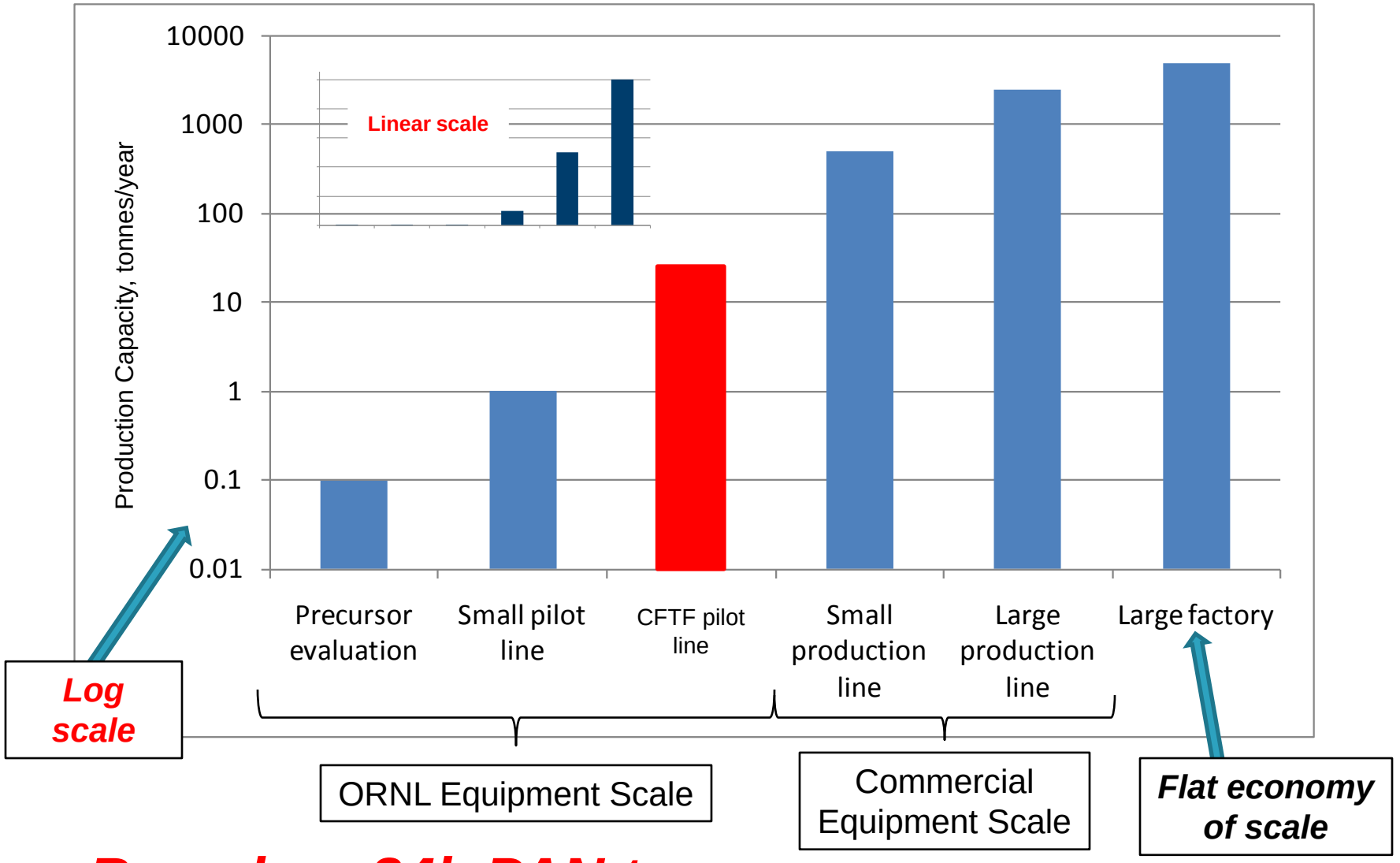
Parameter	Requirement*	Design
Tow band width	300 mm	300 mm
Number of tows	20 @ 24k	24 @ 24k
Line speed	1.5 m/min	2.0 m/min

* Requirements suggested by an industry consultant with > 25 years of industrial experience

In fiber spinning, pilot scale is a “single-position” unit that can be dimensionally replicated to many “positions” in a production facility. CFTF’s melt spinning line satisfies that scale criterion.

This is the final scaling step below full-scale commercial production

Carbon Fiber Line Scale - Capacity



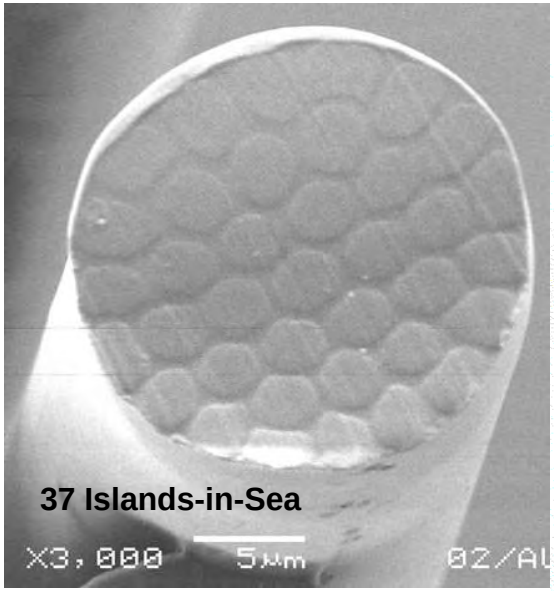
Based on 24k PAN tows

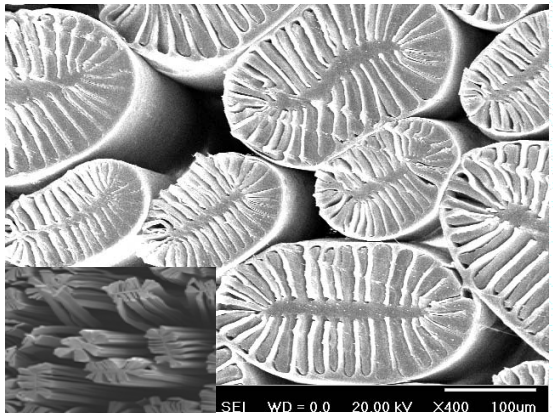
CFTF Designed for Unmatched Flexibility

- **Multiple formats: 3k – 80k tows, webs**
- **Multiple precursors, including all currently under development**
  - **Carbon fiber line: PAN, lignin, polyethylene, pitch, upgradeable for rayon**
  - **Melt spinning line: polyethylene, lignin, pitch, and many other melt processible feedstocks**
- **Multi-component melt-spun precursor fibers**
- **Capability to produce specialty fibers for wide range of end uses**
- **Tri-flow oxidation ovens**
- **Oxidizing capability in low-temperature furnace**
- **Wide range of parametric control, e.g., temperature, fiber drawing**
- **Highly instrumented**
- **General flexibility and high degree of upgradeability**

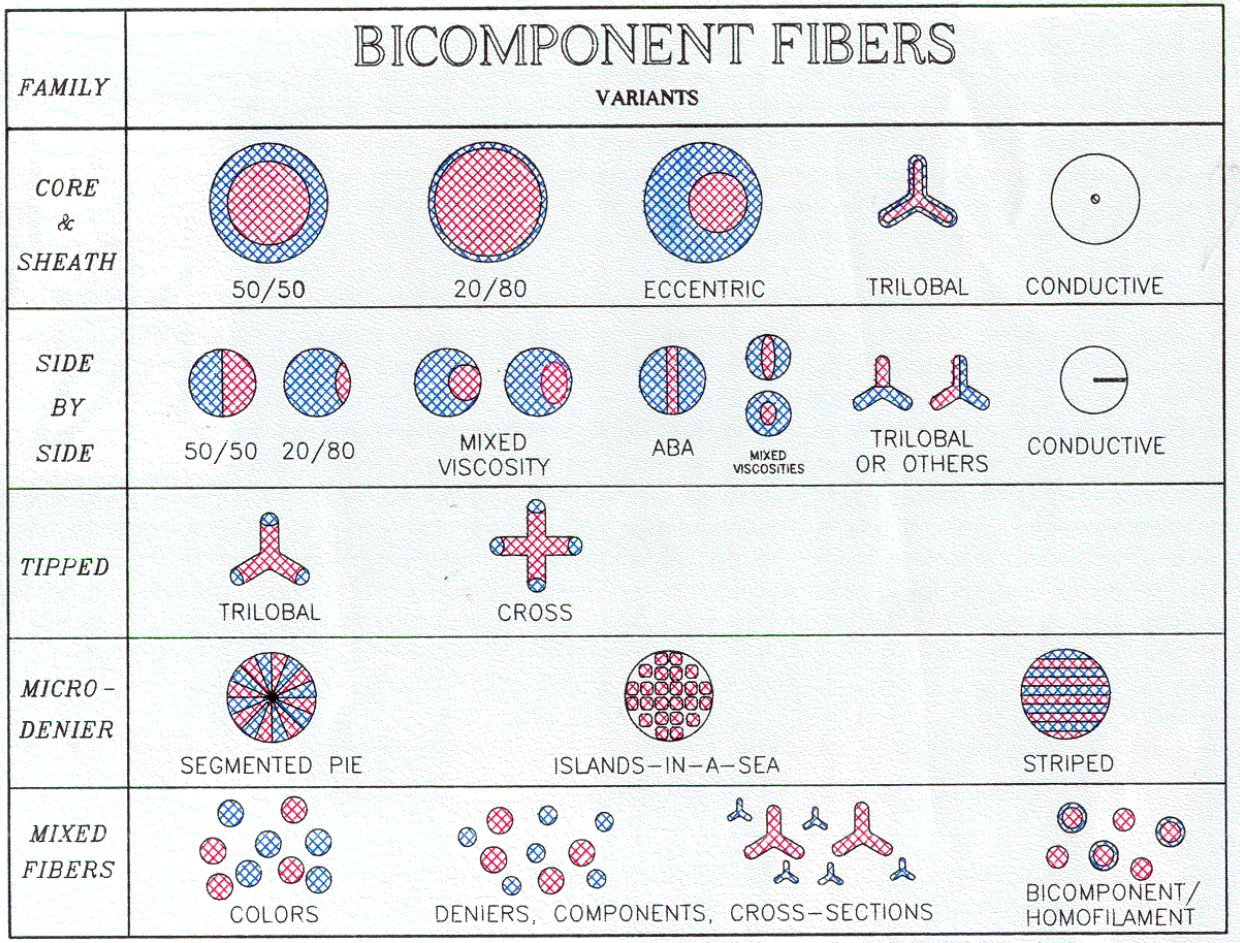
Commercial lines are optimized for single mode of operation

Novel Multi-Component Fiber Technology Offers Extreme Functionality



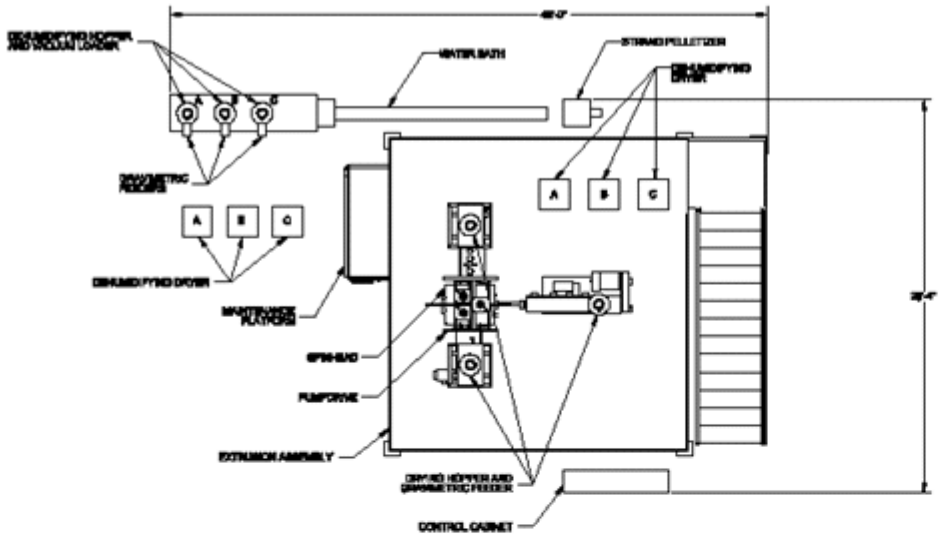


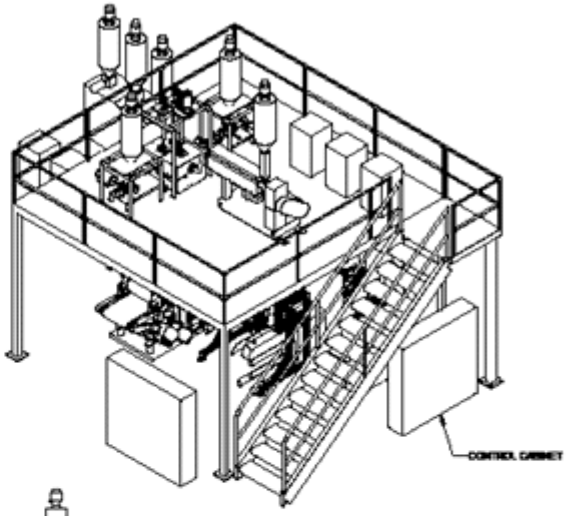
Wing Fibers – 64-Segment Pie with Core and Sheath

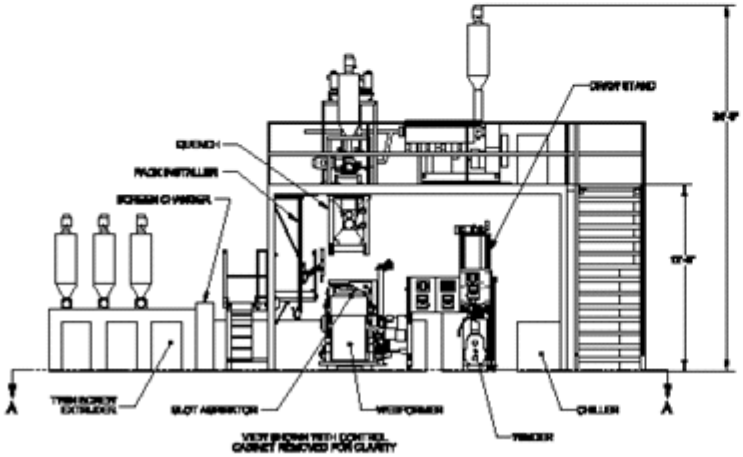


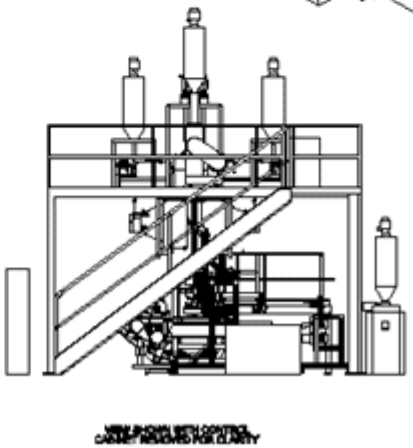
Wing fiber photo courtesy of Hills Inc. and Allasso Industries. Other photos and figures courtesy of Hills Inc.

Preliminary Precursor Fiber Equipment Layout









Figures courtesy of Hills Inc

Unique Carbon Fiber Line Configuration

Every other carbon fiber line in the world is designed for a single material form

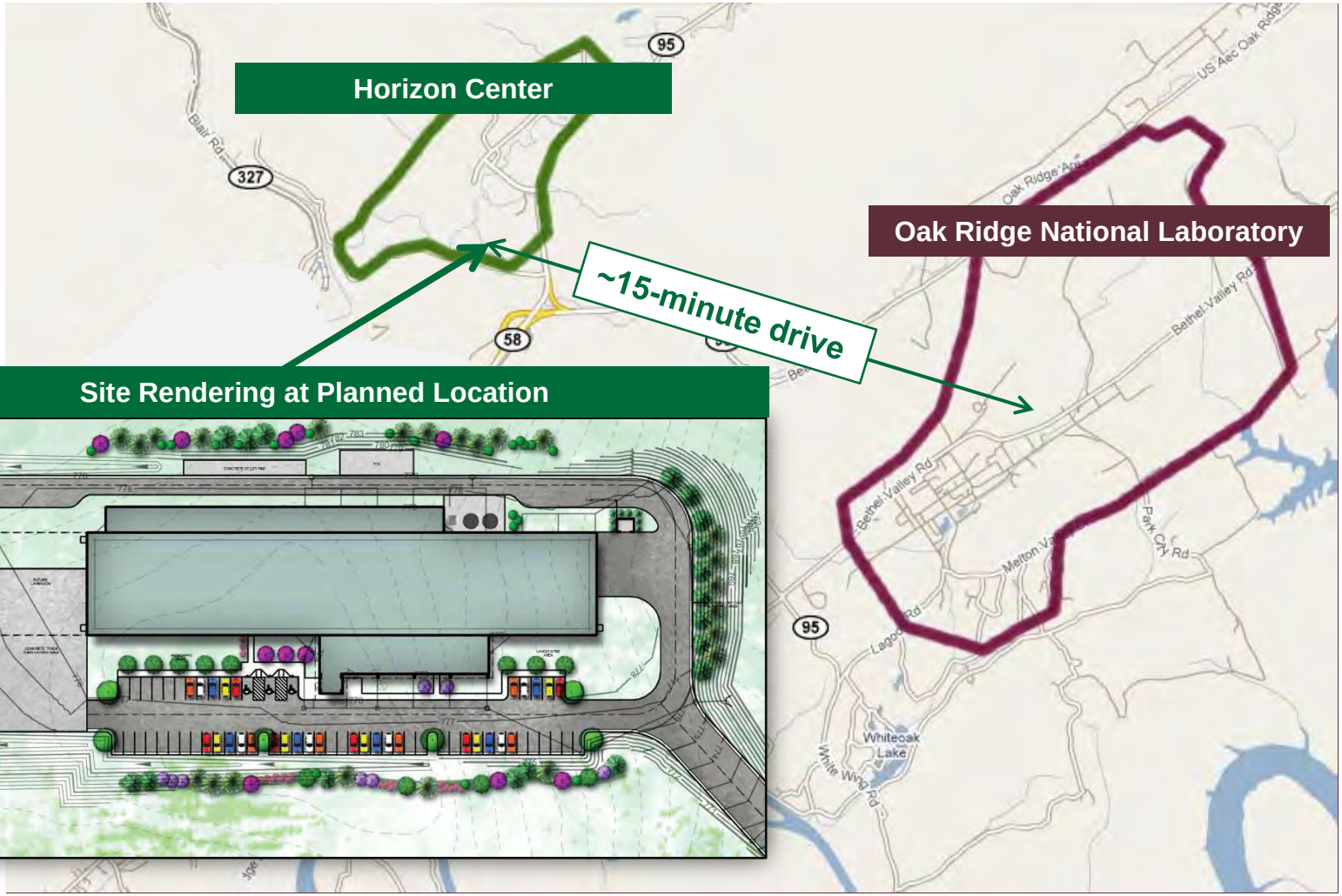
CFTF line will be able to process both tow and mat forms

Photos courtesy of Harper International

Key Milestones

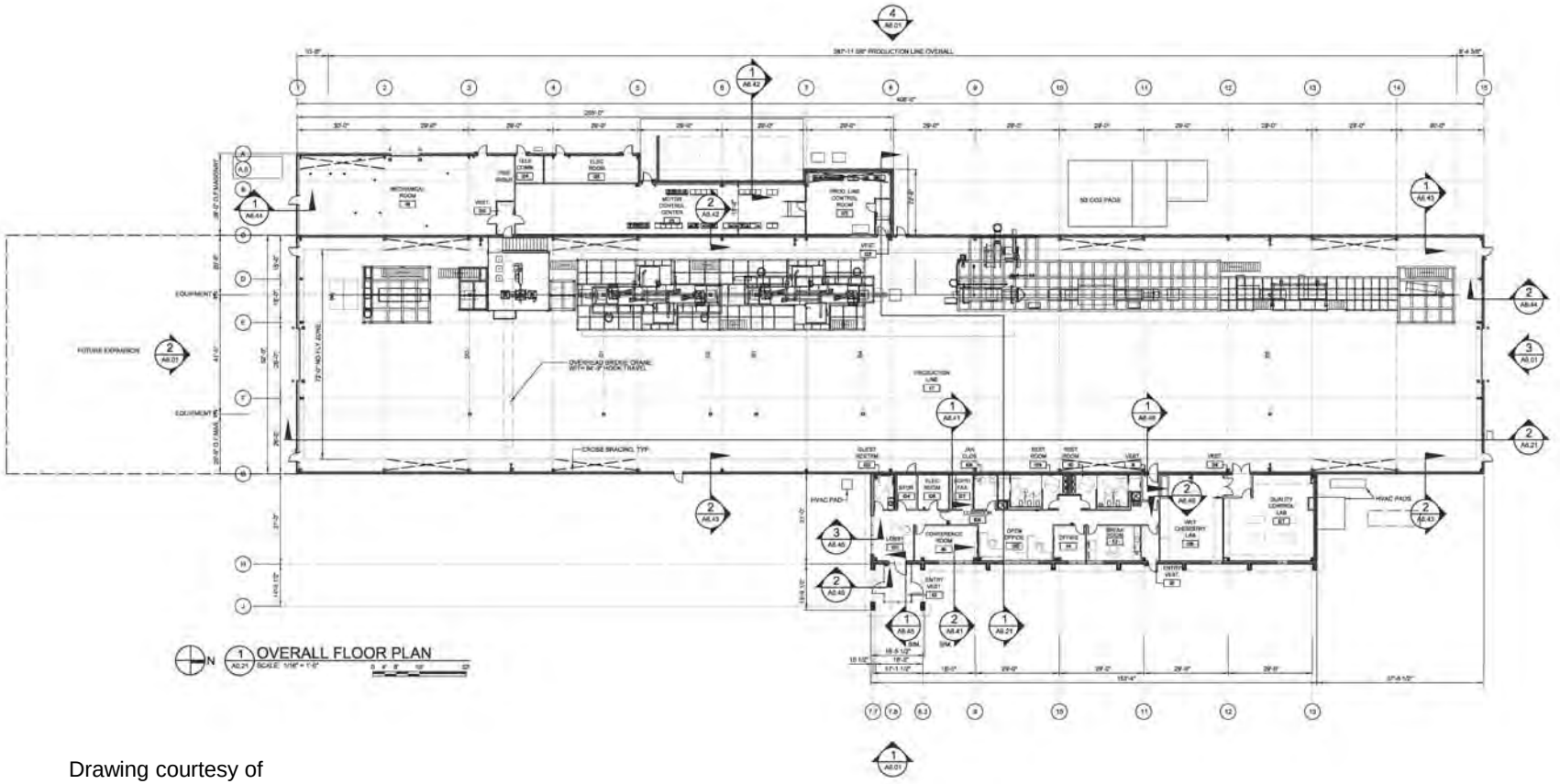
Milestone	Status
Mission need approval	Issued Aug 2009
Equipment RFP's	Issued July 2010
Building lease	Awarded Oct 2010
NEPA documentation	Approved Jan 2011
Procurement authorization	Issued Mar 2011
Groundbreaking	Apr 2011
Equipment contracts	Awarded Mar 2011
Building "dry-in"	Required May-12, forecast Dec-11
Equipment fabricated	Required Mar-13, forecast Aug-12
Equipment installed	Required June-13, forecast Sept-12
Equipment operational	Required Sept-13, forecast Jan-13
Start-up approval	Required Sept-13, forecast Feb-13

Site Was Selected and Characterized



Site plan courtesy of
R&R Partners – Developer
Blaine Construction – Construction manager
Barge, Waggoner, Sumner, and Cannon – Designer

Building Design is Well Along



Drawing courtesy of
R&R Partners – Developer
Blaine Construction – Construction manager
Barge, Waggoner, Sumner, and Cannon – Designer
Harper International and Hills Inc. – Equipment suppliers

Site Work Is Underway

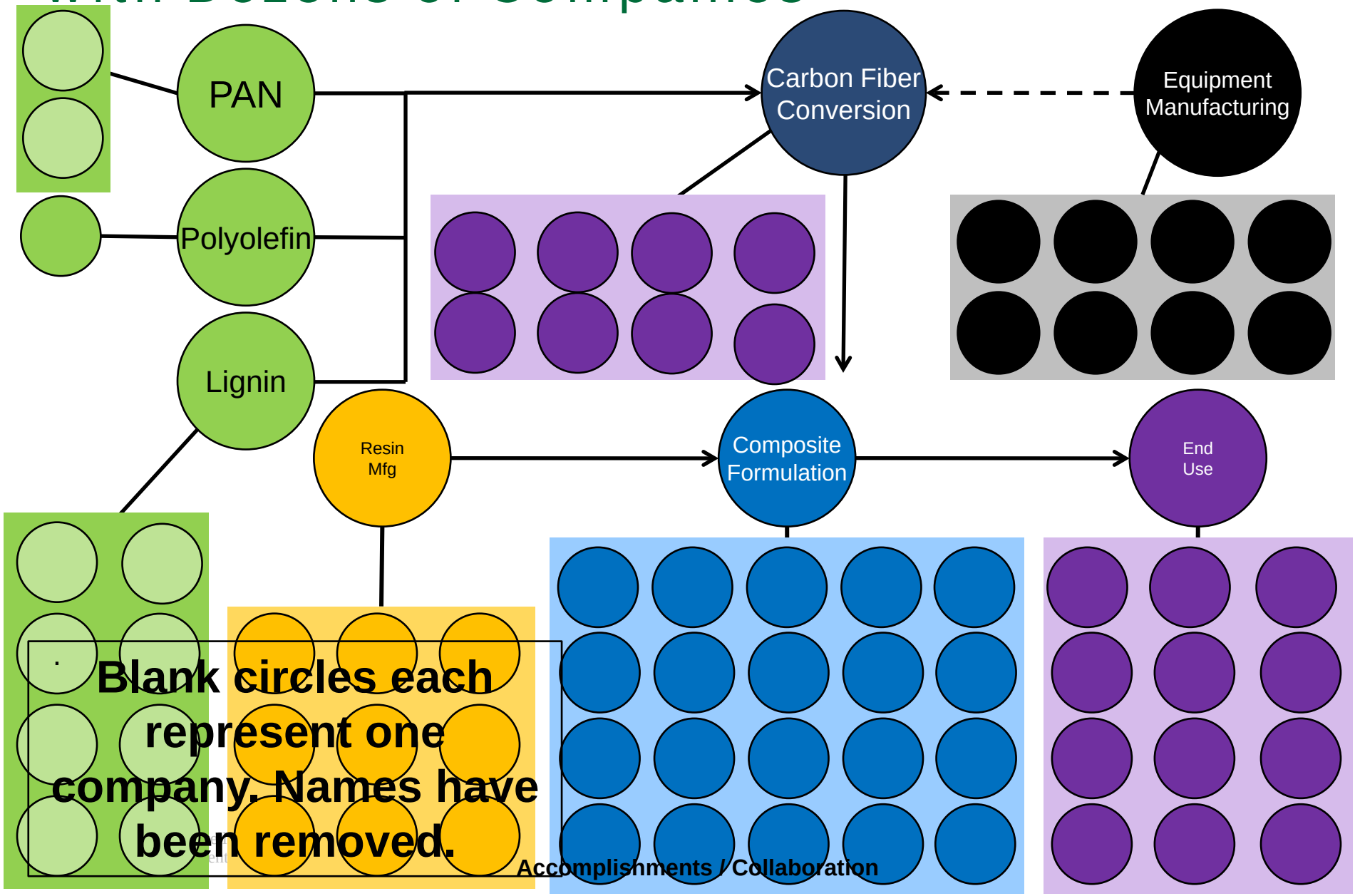
We Have Developed a Three-Step Commercialization Strategy

1. **Establish the Oak Ridge Carbon Fiber Composites Consortium**

2. **Identify and Secure Key Alliance Partners for Raw Materials and Fiber Production**

3. **Develop new CF composites applications with numerous partners**

CFTF Is Driving Collaboration Discussions with Dozens of Companies



Building a cluster around carbon fiber

Carbon Fiber Commercialization Plan

ORNL Research

CFTF Pilot Plant

$2.86M Dept of Labor grant for training technicians in advanced materials – initial focus on carbon fiber composites and PV materials

PARTNERSHIPS

Industry Collaboration

Workforce Development

Roane State Community College

Job Creation

INNOVATION VALLEY INC.

Multiple companies are considering locating CF composites mfg facilities in east TN

Accomplishments / Collaboration

OAK RIDGE National Laboratory

Plans for the Next Year

- **Complete building construction and commissioning**
  - **Ready for equipment milestone date required May-12, forecast Dec-11**
- **Begin equipment fabrication**
- **Begin receiving equipment in early CY12**
- **Develop detailed operations plan**
- **Launch Carbon Fiber Composites Consortium**

Summary

- **CFTF is an essential asset for scaling and deploying low-cost carbon fiber technologies**
- **CFTF addresses cost, inadequate supply chain, and manufacturability barriers**
- **CFTF is a CAPITAL project and is currently within schedule and budget**
- **Within next year, building and significant equipment fabrication should be completed**
- **CFTF is driving enormous collaboration opportunities**