

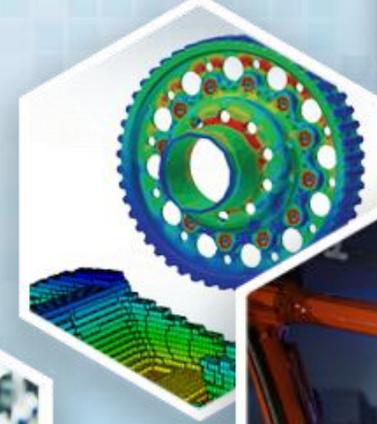
Soydan Ozcan
IACMI Composite Recycling Lead

Uday Vaidya, Cliff Eberle

Recycling/Circular Economy Working Group

IACMI Fall Members Meeting

Oct 7, 2020



Recycling/Circular Economy Working Group Meeting Agenda



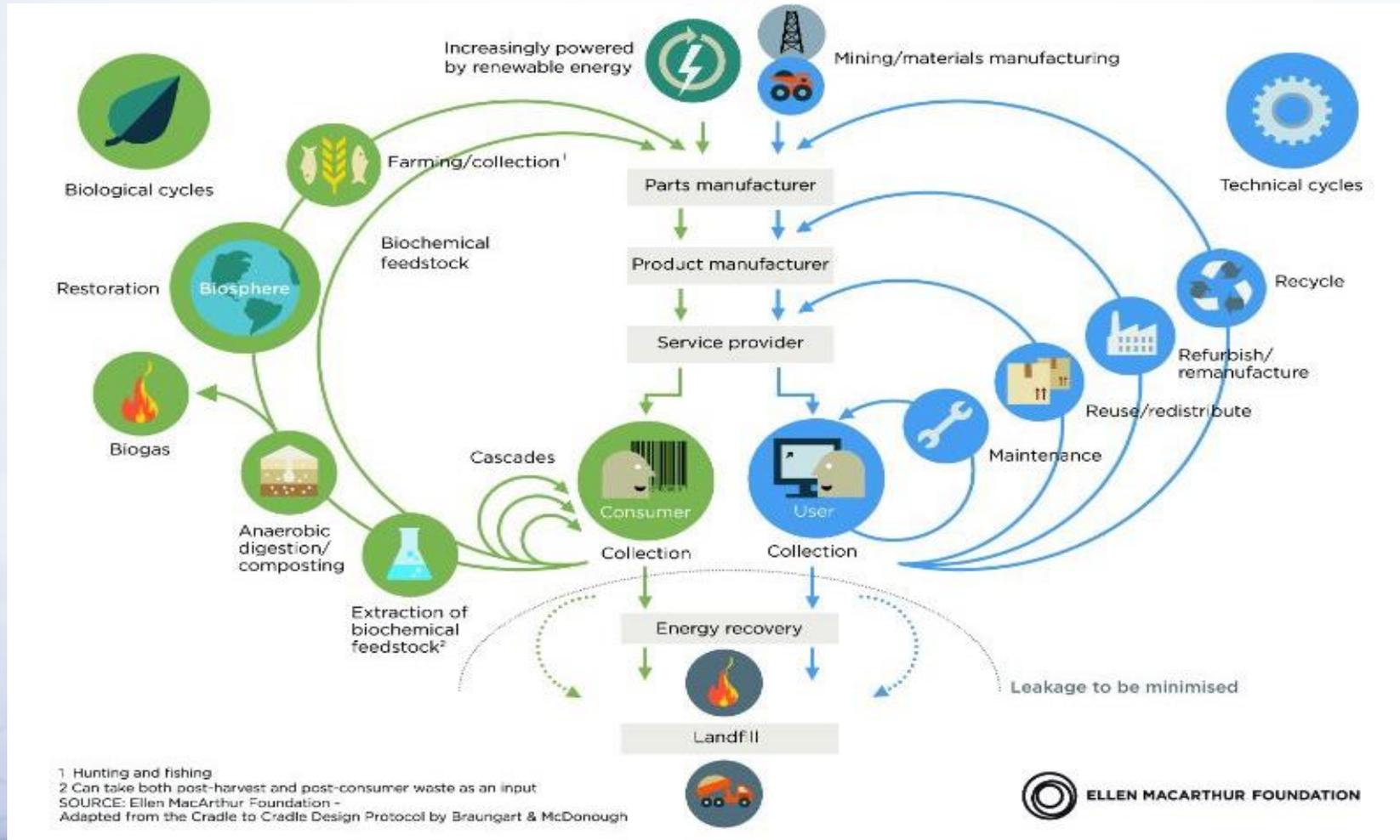
IACMI Fall Members Meeting
Thursday October 8, 2020
10:00am EST – 11:00am EST

Start and End Time	Duration	Topic	Speaker/Moderator
10:00am-10:05am	5 minutes	Welcome	Soydan Ozcan
10:05am-10:10am	5 minutes	Opening Remarks Department of Energy	Alex Fitzsimmons Deputy Assistant Secretary for Energy Efficiency
10:10am-10:25am	15 minutes	IACMI Recycling/Circularity Overview	Soydan Ozcan
10:25am-10:55am	30 minutes	Panel Discussion, Live Question & Answers	Soydan Ozcan Cliff Eberle Uday Vaidya
10:55am-11:00am	5 minutes	Action Items	Soydan Ozcan

Circular Economy – An industrial system that is restorative by design

Regenerate - Substitute materials

Virtualize - Restore





Vision for Composite Recycling and Circular Economy



Research focuses on providing an answer to the 21st century's greatest challenge – How to close the loop on the modern supply chain so that today's composite waste materials become tomorrow's valuable raw materials.

FUTURE CHALLENGE

- Demand for carbon fiber at ~200 million pounds and growing by 10-15% per year
- U.S. glass fiber market expected to increase in volume 20%, from 2.5 billion in 2018 to 3 billion lbs by 2023
- Each year, 4.4 billion lbs of polymer composite materials are sold for use in different automotive applications
- ~130 million lbs of composite wind turbine end-of-life waste generated annually and expected to increase by more than 5 times by 2030
- BAAM technology has seen a large growth in recent years in terms of equipment size capacity throughput as well as business implementation (eg. ~30,000lb precast concrete print, 5000lb boat printed in once)

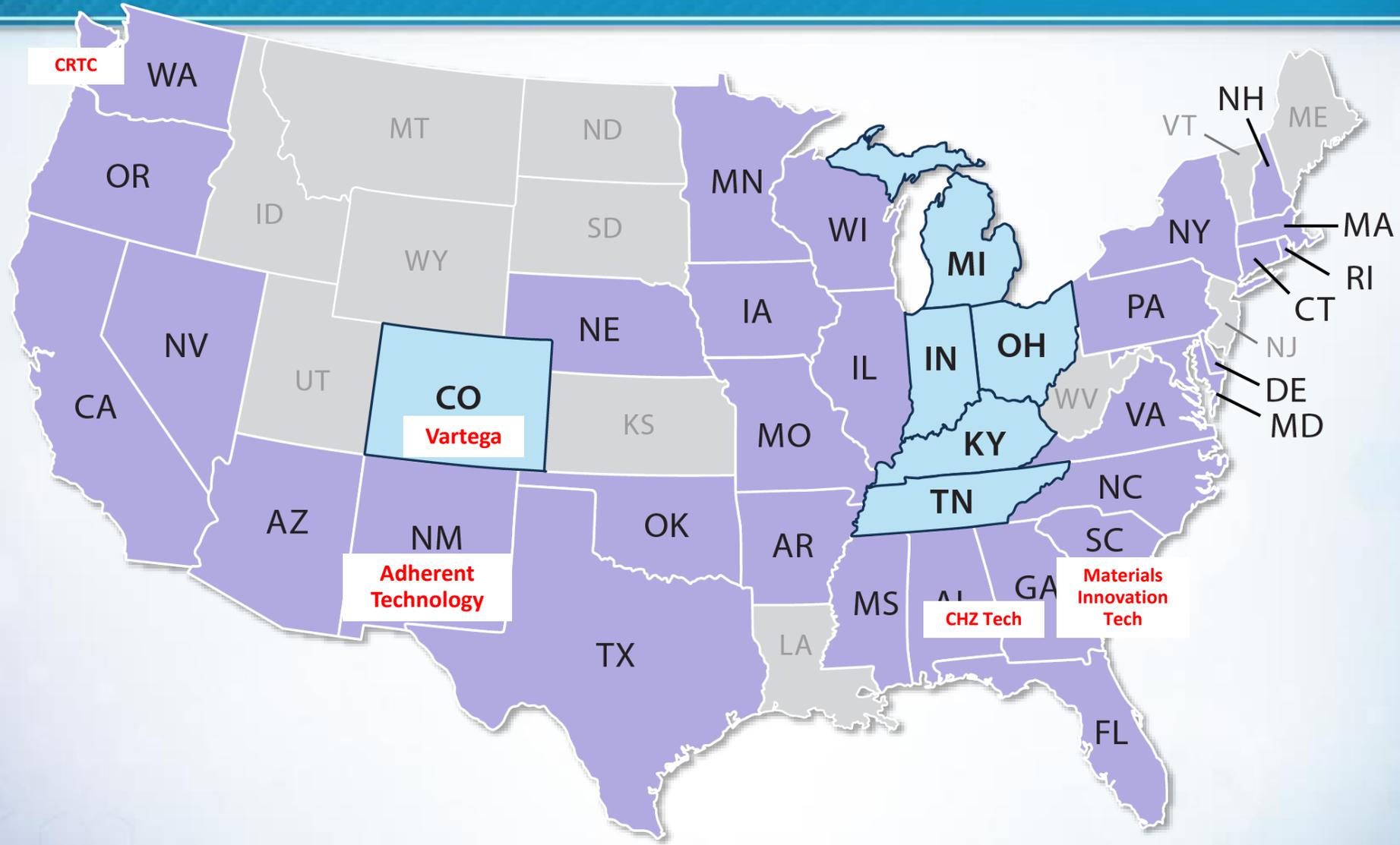


VISION

- Co-develop next generation polymer composites recovery technology with industry partners on-site, speeding both innovation and time to commercialization
- Develop and demonstrate, at scale, new recycled polymer composite intermediate materials and end applications to drive recycled composite industrial demand
- Unified, in-house composite recovery, preforming, and manufacturing equipment capabilities streamline iteration of circular economy technology
- Network between industry partners to establish supply chain feasibility, techno-economic analyses, and material lifecycle assessments



Composite Recycling Activities



Fast forward - 5 Years of IACMI composite recycling



2016



Composite Recycling Technology Center Port Angeles, WA opening and MOU signing ceremony

2016-2017-2018



IACMI Composite Recycling Roadmapping Workshops

2015 → 2020



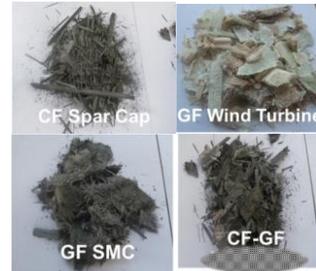
Participate conference panels, support various CAMX, SAMPE, ACMA, Sustainability Coalition 2015-2020

2015 → 2020



Published journal papers and selected for cover page of "Recycling" journal for June 2019

2015 → 2020



8 IACMI Recycling Projects with total of 30 industrial collaborators

2016



Manufacturing Thermoplastic Wind Turbine Blade
Wind Technology Center-NREL

2015



IACMI and ACMA have entered into a partnership agreement.

2015 → 2020



Numerous engineer interns trained in composite recycling

2019



IACMI SURF Facility injection molded the automotive fender using recycled carbon fiber reinforced PA6

Related industrial partners



New Capabilities for Advanced Manufacturing Recycling



Ribbon cutting ceremony of
Recycling and recovery of advanced
manufacturing composite materials
At ORNL's Manufacturing Demonstration
Facility

September 23, 2020

Enabling the Circular Economy

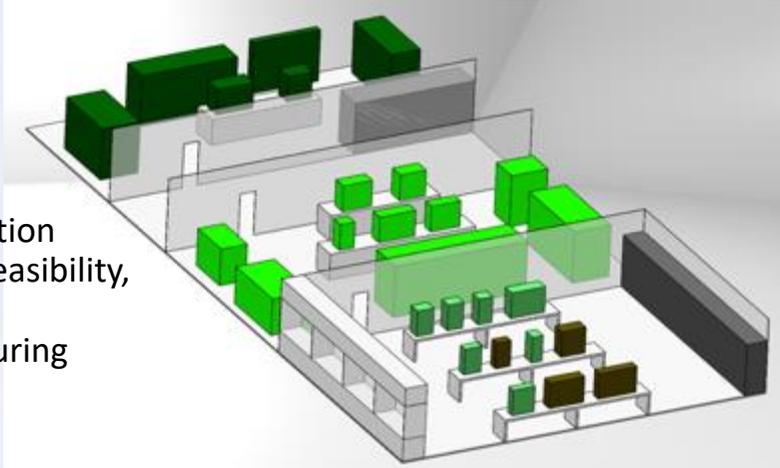
“Develop Value Added Recycled Feedstocks for Additive and Composite Manufacturing”



Rapid Innovation Capability

Low Bay
50' x 100'

- Characterization
- Bench Top Feasibility, Recycling & Remanufacturing



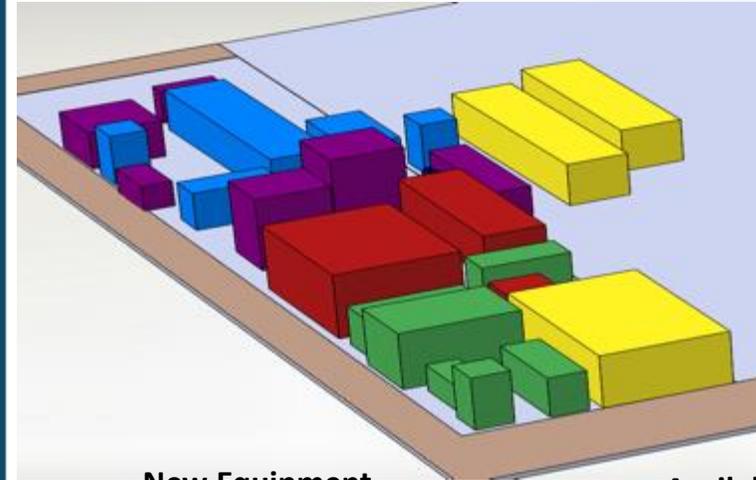
New Equipment

Lab-Scale Recycling & Recovery

Manufacturing

Characterization

Scale up Capability



High Bay
50' x 200'

- Commercial Scale Manufacturing Systems
- Recycling & Recovery Equipment

New Equipment

Recycling & Recovery

Available Equipment

Thermosets

Thermoplastics

Additive Manufacturing

Automation and Molding

Circular economy supporting capabilities:

- **Green** boxes are new equipment
- Other colors are MDF existing capabilities

Recent High Throughput Size Reduction Equipment for Developing Circular Economies



➤ Waterjet Cutting

WARDJet X-1530

5-axis cutting head

Chopping 10' x 8', complex composite



WARDJet X-1530
Waterjet Cutter

➤ Stacked Shredder & Granulator

Cumberland MR 40120 & 56U

Size-Reduce to 4mm granulates



Cumberland MR40120
Shredder

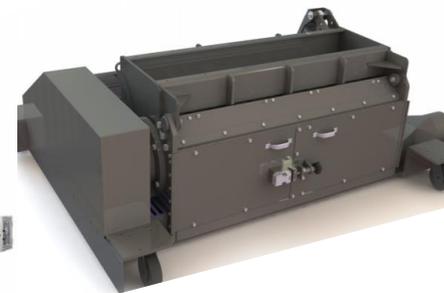
➤ Twin Screw Extruder and Pelletizer

Leistritz ZSE 27 MAXX

300 lb/hr throughput



Plasticator



Cumberland
56U Granulator



Leistritz ZSE 27 MAXX
Twin Screw Extruder
and Pelletizer

➤ Single Screw Plasticator

Current Pilot Scale Capabilities

Thermoplastics

➤ Injection Molding

Milacron – 300 T

Boy – 35 T

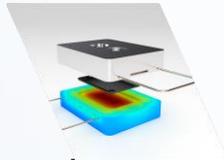


➤ Compression Molding

Trinks - 500 Ton

Beckwood - 100 Ton

Equipped with Roctool advanced Heat & Cool Technology



➤ Thermoforming

➤ Big Area Additive Manufacturing

100 lb/hr throughput

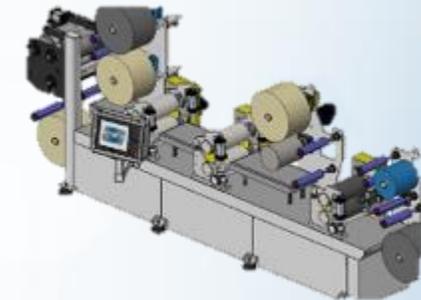


Thermosets

• Multi Material SMC Line



• Prepreg Molding



• Thermoset Printing





COMPOSITE INSTITUTE FOR ADVANCED MANUFACTURING INNOVATION

iacmi
INSTITUTE

IACMI.ORG

DESIGN, MODELING & SIMULATION

COMPOSITE MATERIALS AND MANUFACTURING

VEHICLES

WIND TURBINES

COMPRESSED GAS STORAGE

THE NEXT GENERATION

INCREASING WORKYIELDING

WITH THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

ENGAGE IN PROJECTS

LEVERAGE INVESTMENTS

COLLABORATE ACROSS THE INDUSTRY

First Poll – 2 Questions at Same Time

- ◆ How does your company currently dispose of composites scrap and composites products at end of life predominantly?
 - ◆ Landfill
 - ◆ Incinerate
 - ◆ Recycle
 - ◆ Other
 - ◆ Don't know
- ◆ What type of polymer composites does your company primarily use?
 - ◆ Thermosets
 - ◆ Thermoplastics
 - ◆ Both

Discussion



- ◆ What challenges exist in moving from the status-quo to a circular economy?
- ◆ What are the specific waste or recycling challenges your company faces and how do you see these challenges evolving in the near-, mid- or long-term for the industry
- ◆ What would be considered success for your company in developing a circular or sustainable industry?
- ◆ What role does life cycle analysis (LCA) play in your company's sustainability objectives?
- ◆ What are the actions that this group needs to take?

Second Poll – 1 Question



- ◆ How important is LCA to your company's decision making?
 - ◆ Very important
 - ◆ Somewhat Important
 - ◆ Neutral
 - ◆ Not really important
 - ◆ Not at all important

Poll #3: Meeting Frequency



◆ How often should this working group meet?

◆ Quarterly (4x per year)

- ◆ IACMI virtual member meeting - week of February 15, 2021
- ◆ SAMPE Long Beach – May 24-27, 2021
- ◆ IACMI summer meeting Detroit – week of July 19, 2021
- ◆ CAMX Dallas – October 18-21, 2021

◆ Bi-monthly (6x per year)

- ◆ Four meetings above plus two additional meetings

◆ Monthly (12x per year, or 11x if December skipped)

- ◆ Four meetings above plus virtual in other months