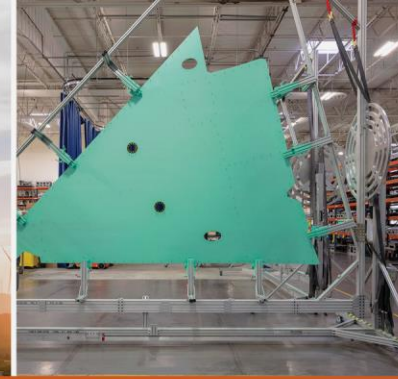


# CF 23 CARBON FIBER



PRESENTED BY:



## Carbon Fiber and Sustainability: Where we are today

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# Sustainability – What it is and what it is not

Sustainability is Not:

Just the ability to recycle  
some components at end of  
life

**OR**

Continuing the use of  
petroleum in any raw material  
or process for composites

Sustainability is:

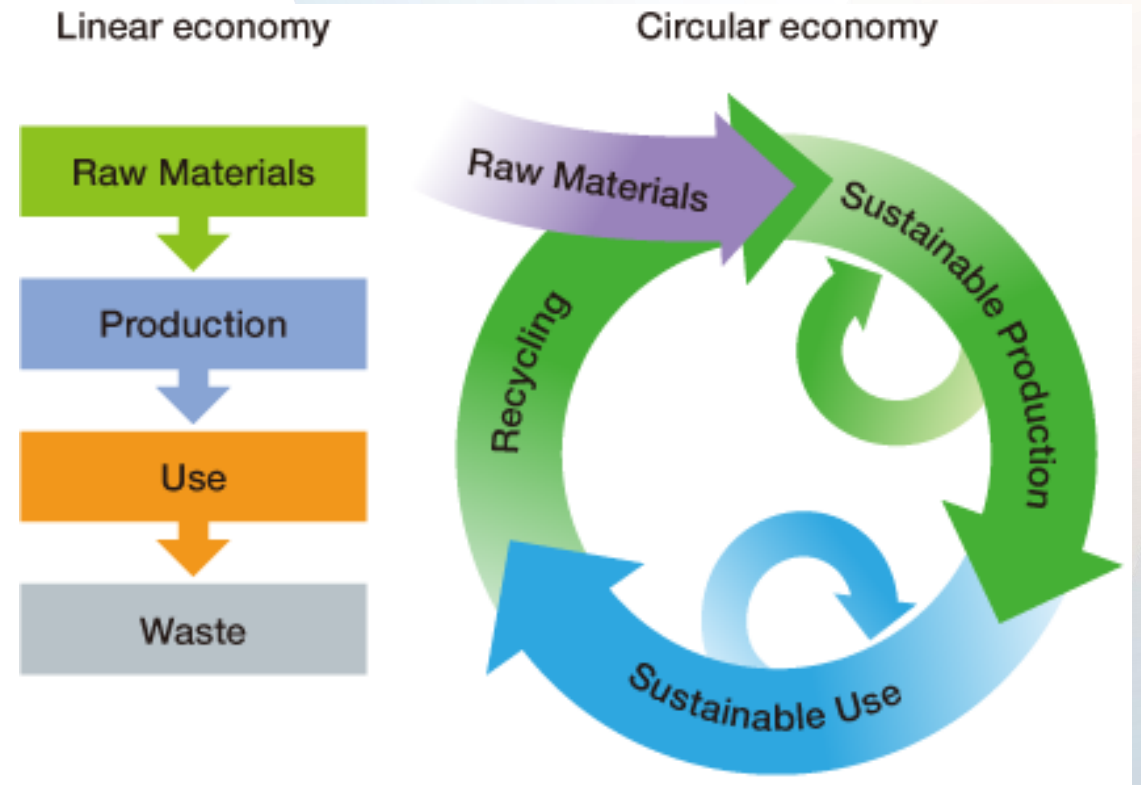
Use of plant or biomass  
based or recycled raw  
materials and precursors

**AND**

Use of renewable energy  
sources for all composites  
processing

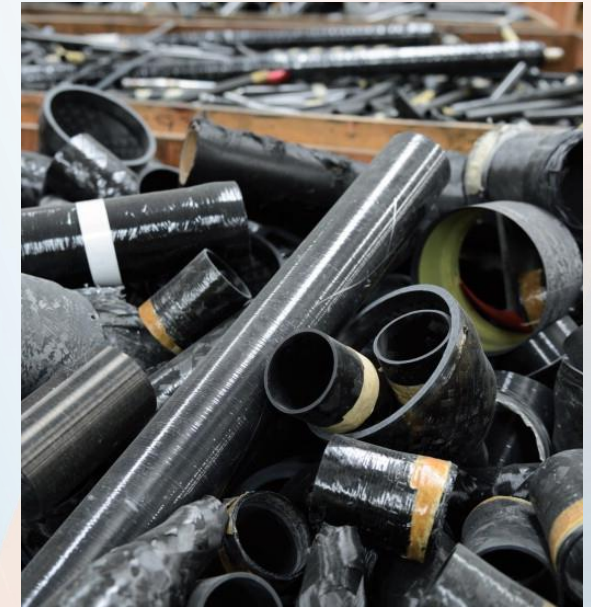
## Linear vs Circular Economy

- Current State of the Art is Linear
  - 1) Petroleum precursors
  - 2) Carbon fibers
  - 3) Carbon fiber composites
  - 4) Use until worn out
  - 5) Grind up and Landfill
- This has to change to achieve sustainability



## What is our Biggest Problem (Challenge?)

- Wind Turbine Blades at end of life - Spar is mostly carbon fiber
- Cut up and landfilled
- New Turbines in Europe using almost all carbon fiber
- Potential for 50 million tons of waste by 2050



## Some Other Challenges

- Aircraft
  - Boeing 787 and Airbus A350
  - New eVTOLs mostly carbon fiber
- Automotive
  - Carbon fiber composites in new cars, pickups, and large trucks
- Sporting Goods
  - Tennis rackets, golf clubs, helmets, paddleboards,.....



## Where are we Today?

- Beginning to reclaim some carbon fiber
  - Usually chopped up and pyrolyzed to remove resin
- Starting to reclaim some parts of wind turbine blades – spars are hard to remove
- Carbon fiber thermoplastics usually cut up and reprocessed



# The Future is Coming

- Plant fiber based Carbon Fiber
  - Flax, corn stalks, wood cellulose waste
- New Precursors for Carbon Fiber
  - Plant-based acrylonitrile
    - Southern Research to Trillium/Solvay
  - Lignin waste from paper processing
  - Nanocellulose fibrils



## A Little Detail – How We Get There



- Example 1 – Carbon Fiber
  - Start with bio-based precursors like lignocellulose
  - Extract sugars using hydrolysis
  - Synthesize acrylonitrile from sugars to make PAN
- Example 2 – Epoxy Resin
  - Plant oils, lignin, rosin as precursors
  - Biomass sugars converted into epoxy amines
  - Bisphenol from Magnolia trees that doesn't disrupt endocrine system



## Bottom Line – Wrap Up

- We have a lot of work ahead of us
- Engineers are going to be key to meeting this challenge
- Good News – the composites industry is engaged and working on it
- Everyone in this industry needs to get involved in meeting the challenge



# Thanks for Listening

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