

# Advances in Pultrusions for the Wind Sector

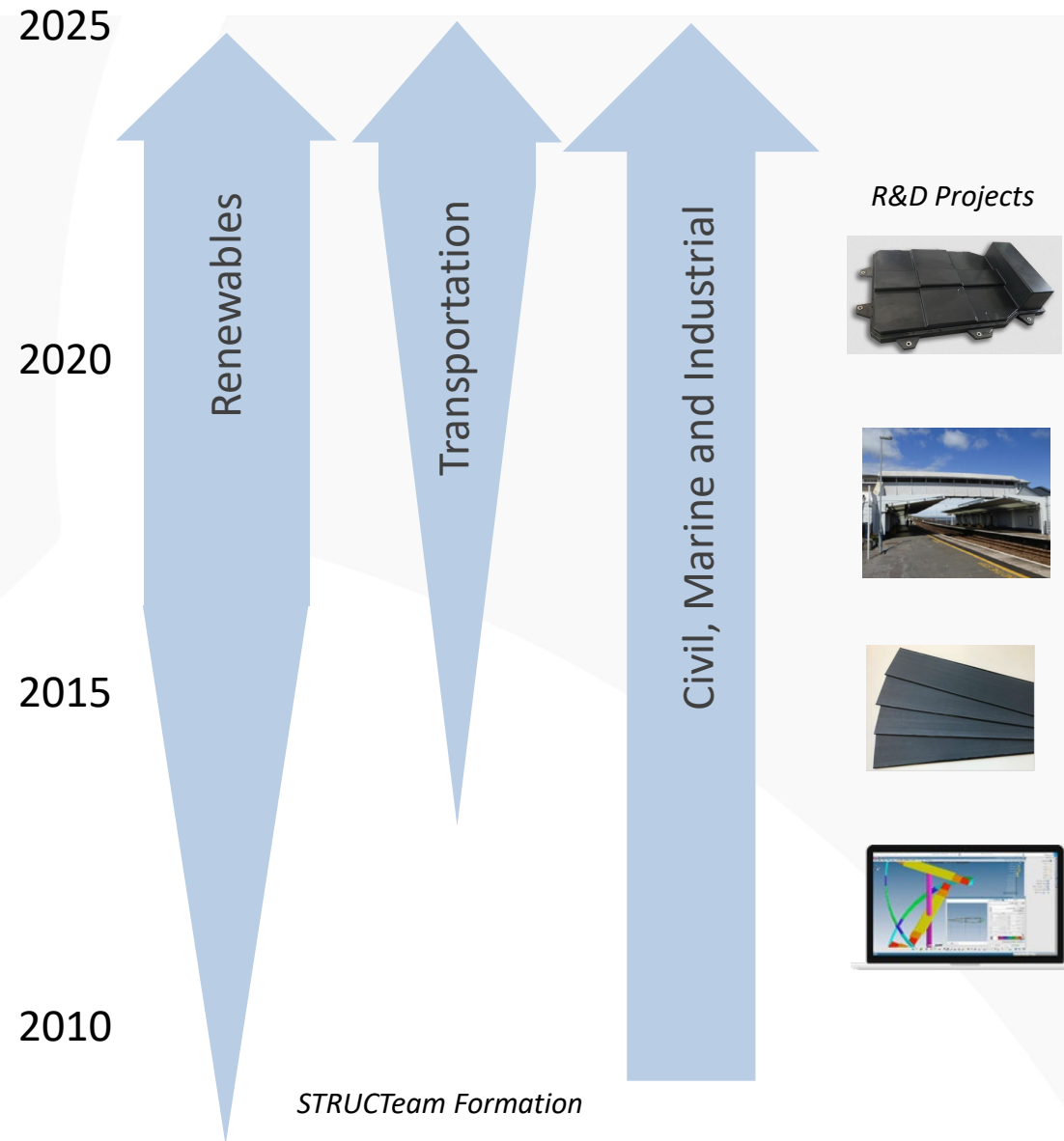
North American Pultrusion Conference 2023  
Julien Sellier



# STRUCTeam Ltd. Introduction



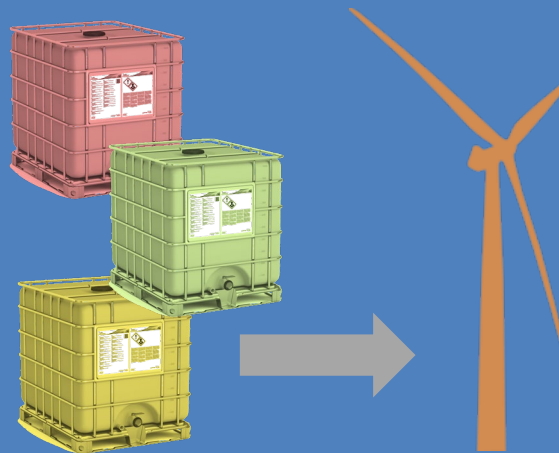
Independent multi sector composite experts



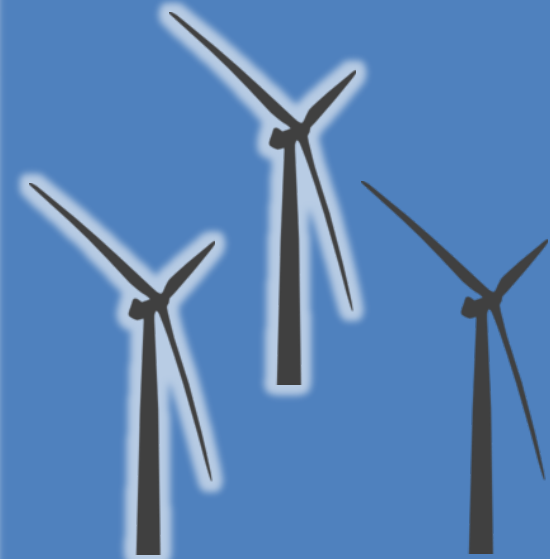
Assembly of supply chain  
for glass pultrusion with  
industry leaders



Active screening of  
alternative resins

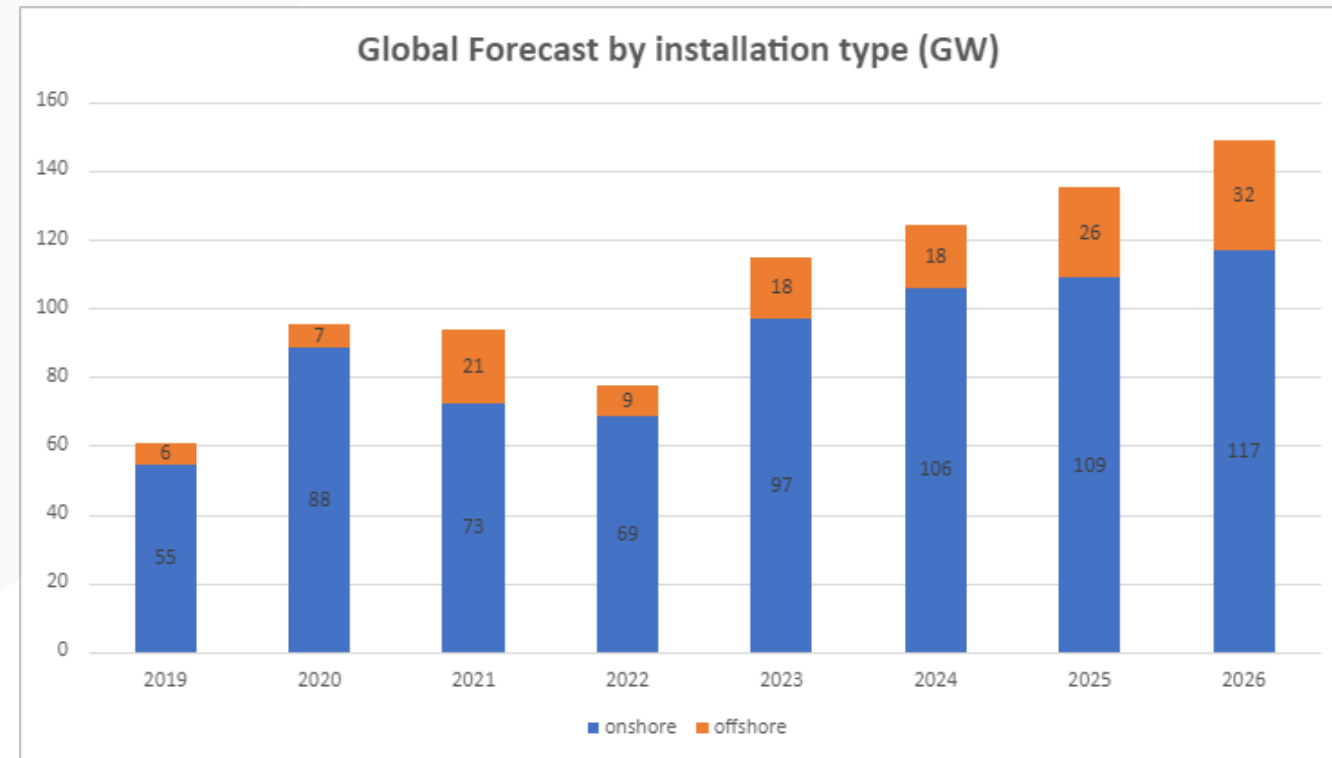


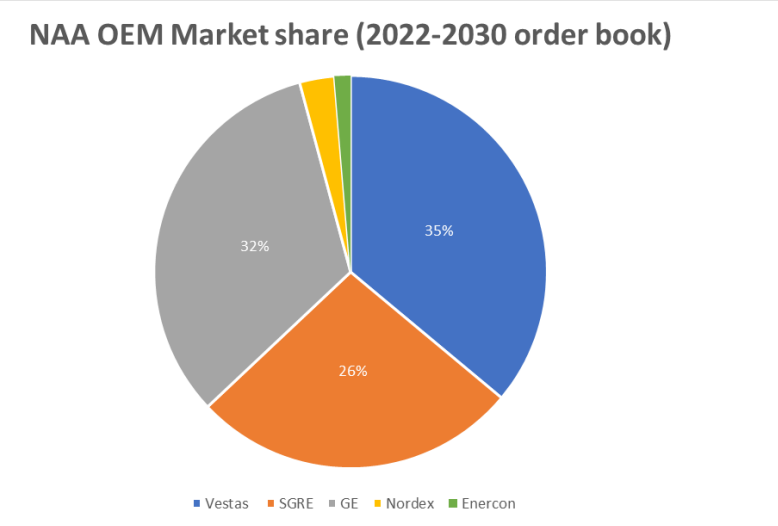
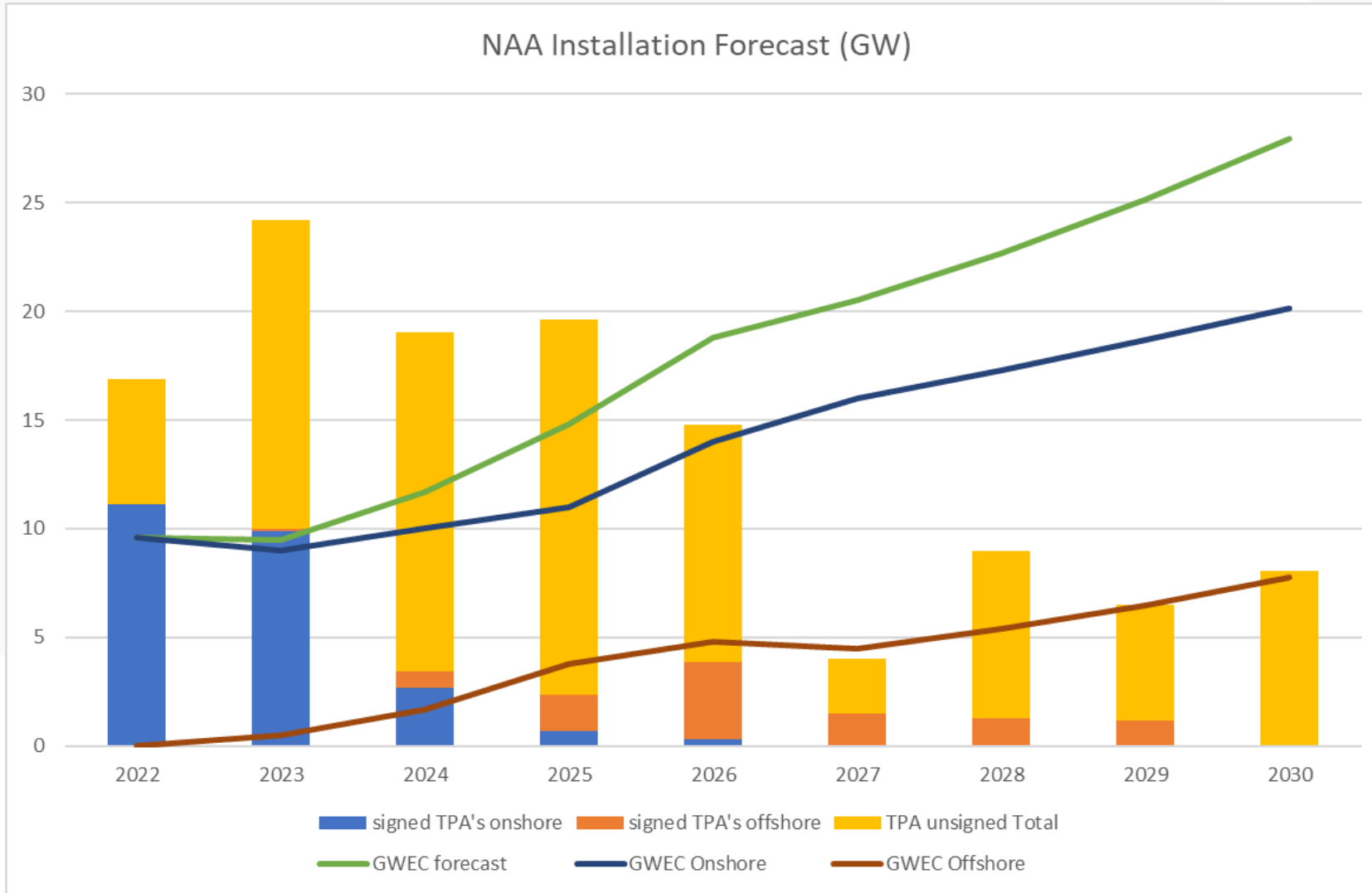
Responsible use of carbon  
fibre



# 5 Year Wind Energy Forecast

- Turbines keep growing in size
  - ⊗ Onshore:  
3-4MW/60-70m → > 5-6MW/ 75-80m
  - ⊗ Offshore:  
6-8MW/80m → 15MW+/ >110m
- Onshore growth drivers: Cost driven / more competitive
  - ⊗ Subject to volatility of costs
  - ⊗ Short term order book
  - ⊗ Blade are > 10 % of the Wind farm cost
- Offshore growth drivers:
  - ⊗ Long term order book
  - ⊗ Blade are < 5 % of the Wind farm cost

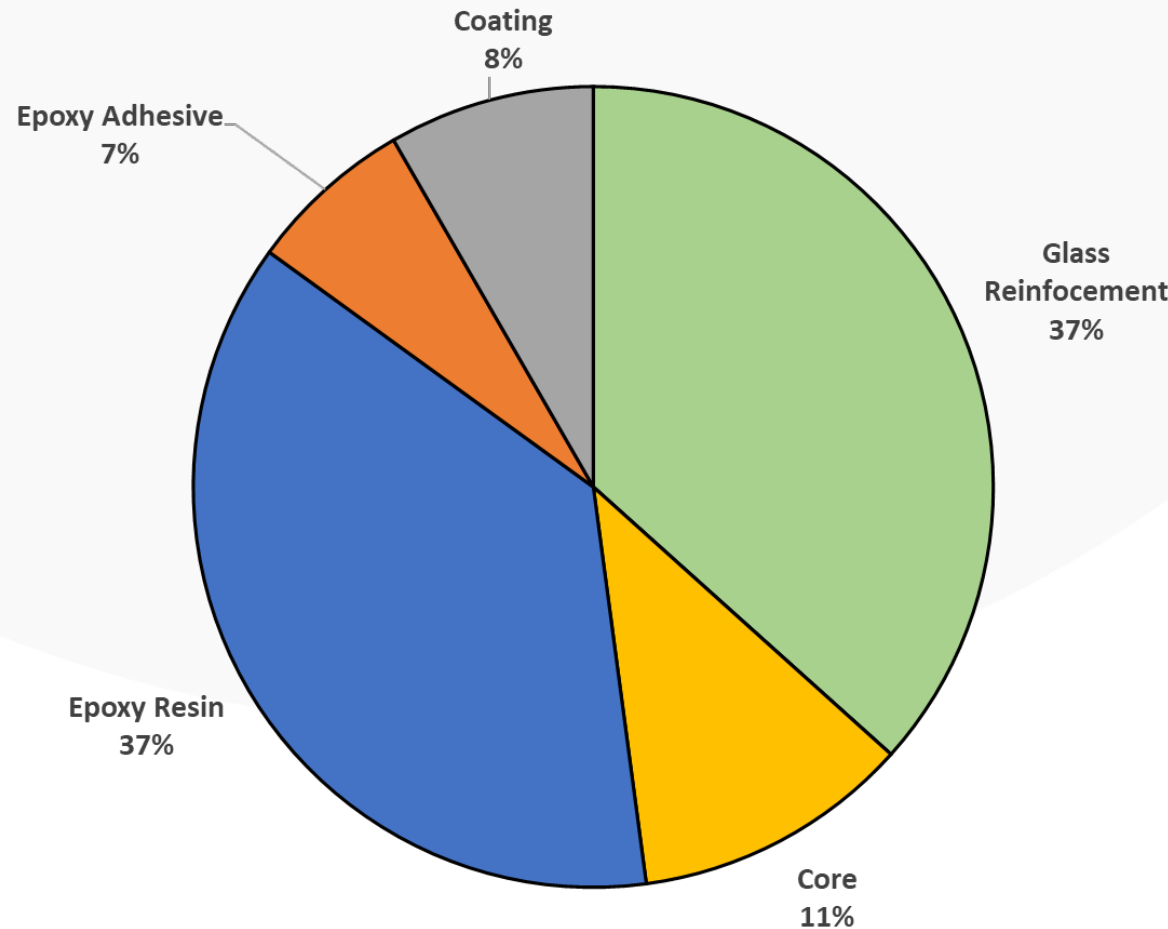




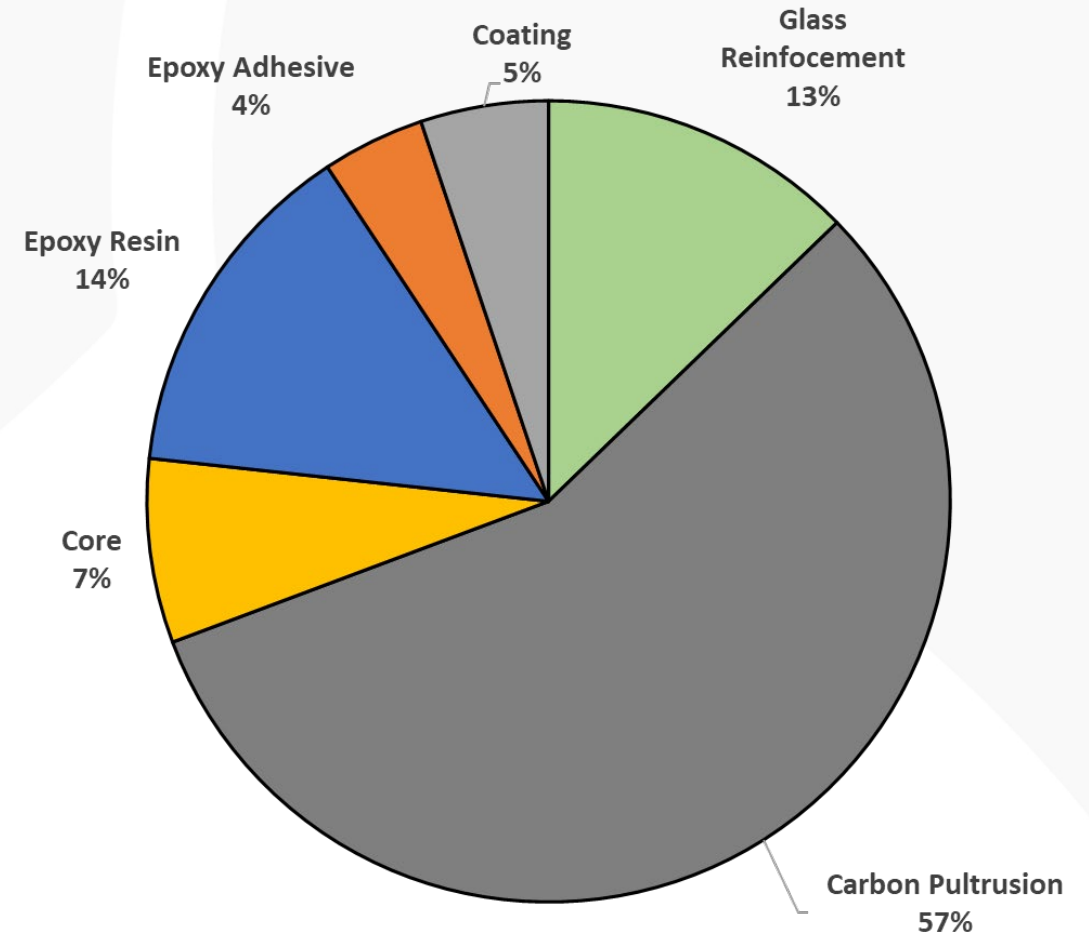
# Breakdown of Blade Material Type by Value

Example of material breakdown for a 78.5m Blade, 4MW Turbine

### 78.5m 4MW - H-Glass Infused Spar Cap



### 78.5m 4MW - Carbon Pultruded Spar Cap



# Blades are Challenging Composite Structures

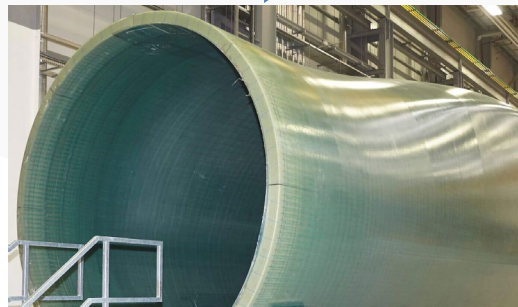
Large component



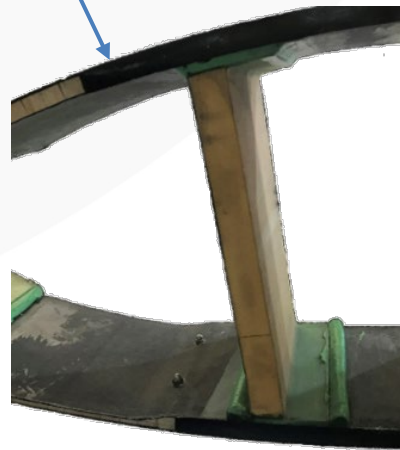
Pre-cured components



Sandwich laminate



Thick monolithic laminate



Adhesive bonding

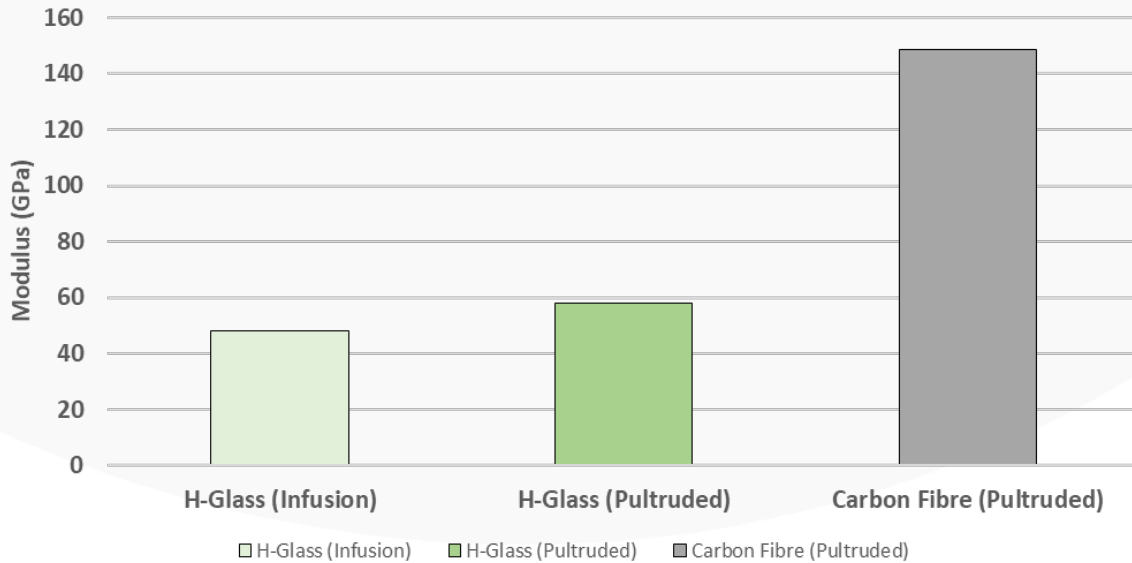


Systems

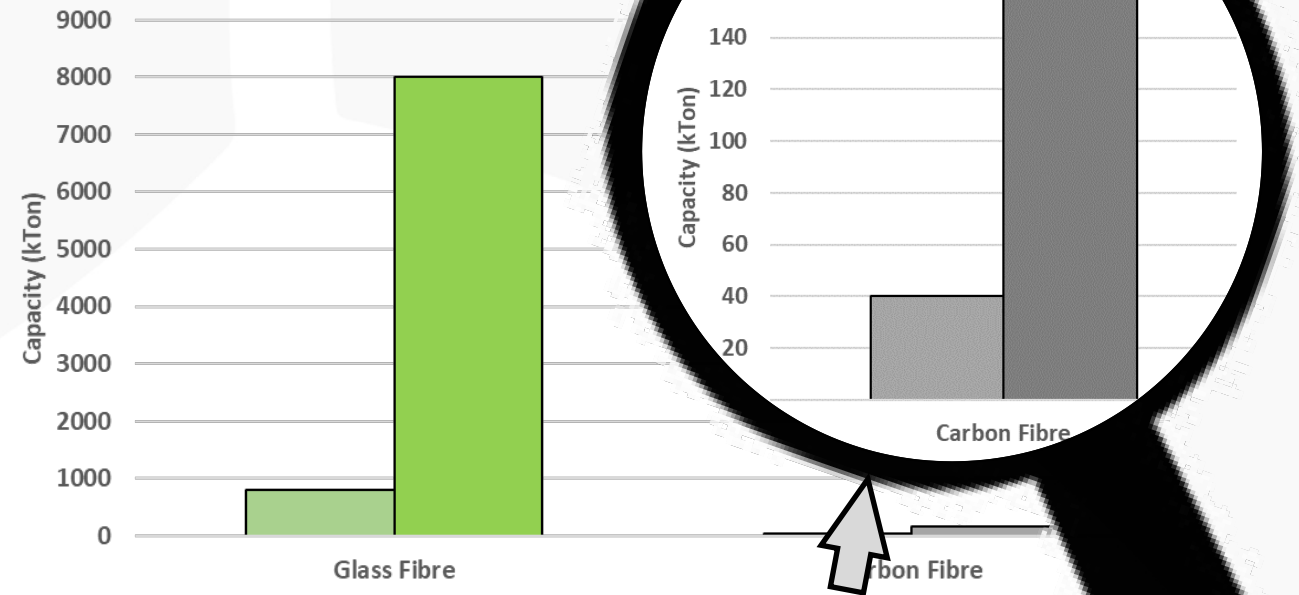
# Influencing Factors – Sparcap Fibre Selection



Spar Cap Fibre Type Modulus



Fibre Type Global Capacity



Sparcap fibre selection is strategic



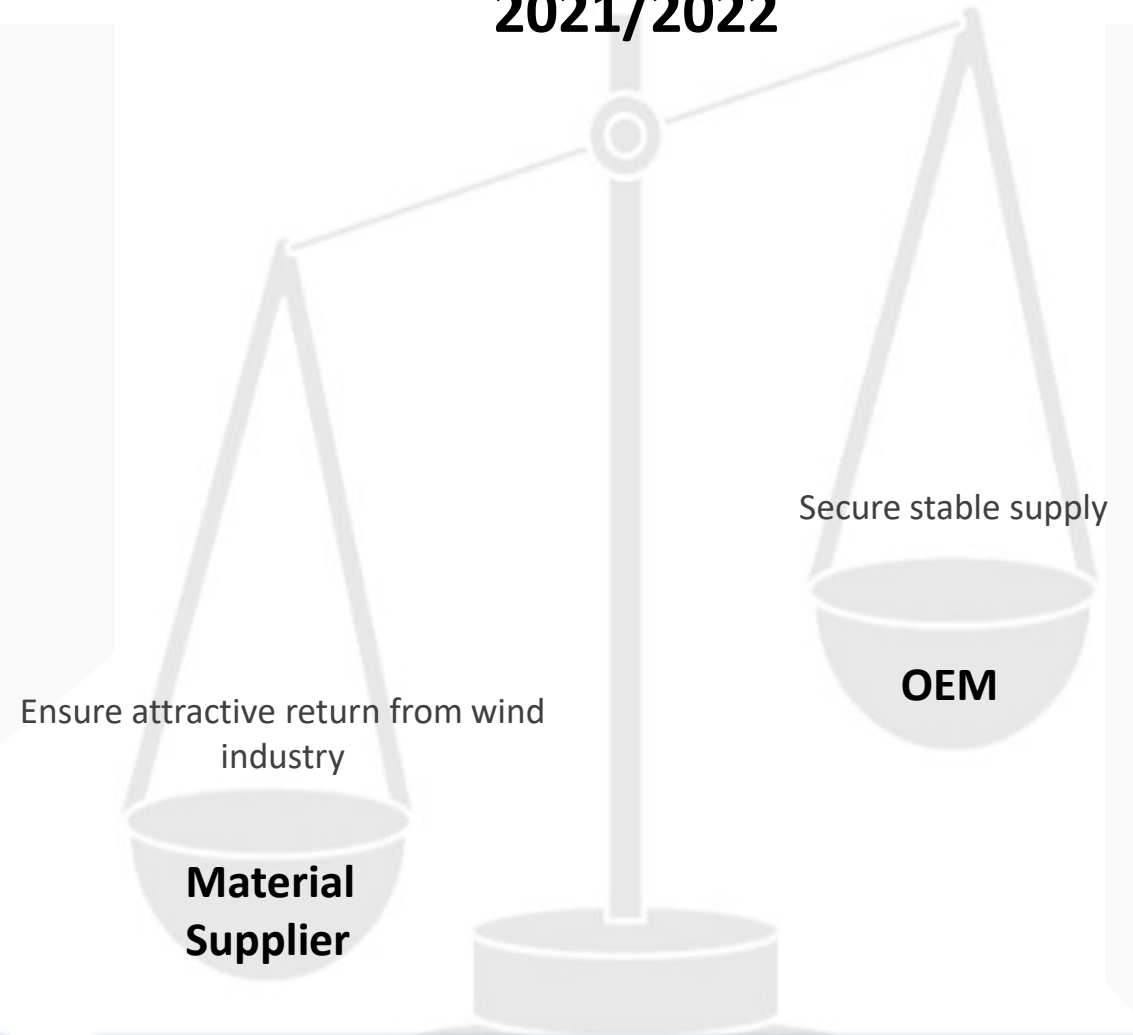
# Supply Chain Influencing Factors

**2015**



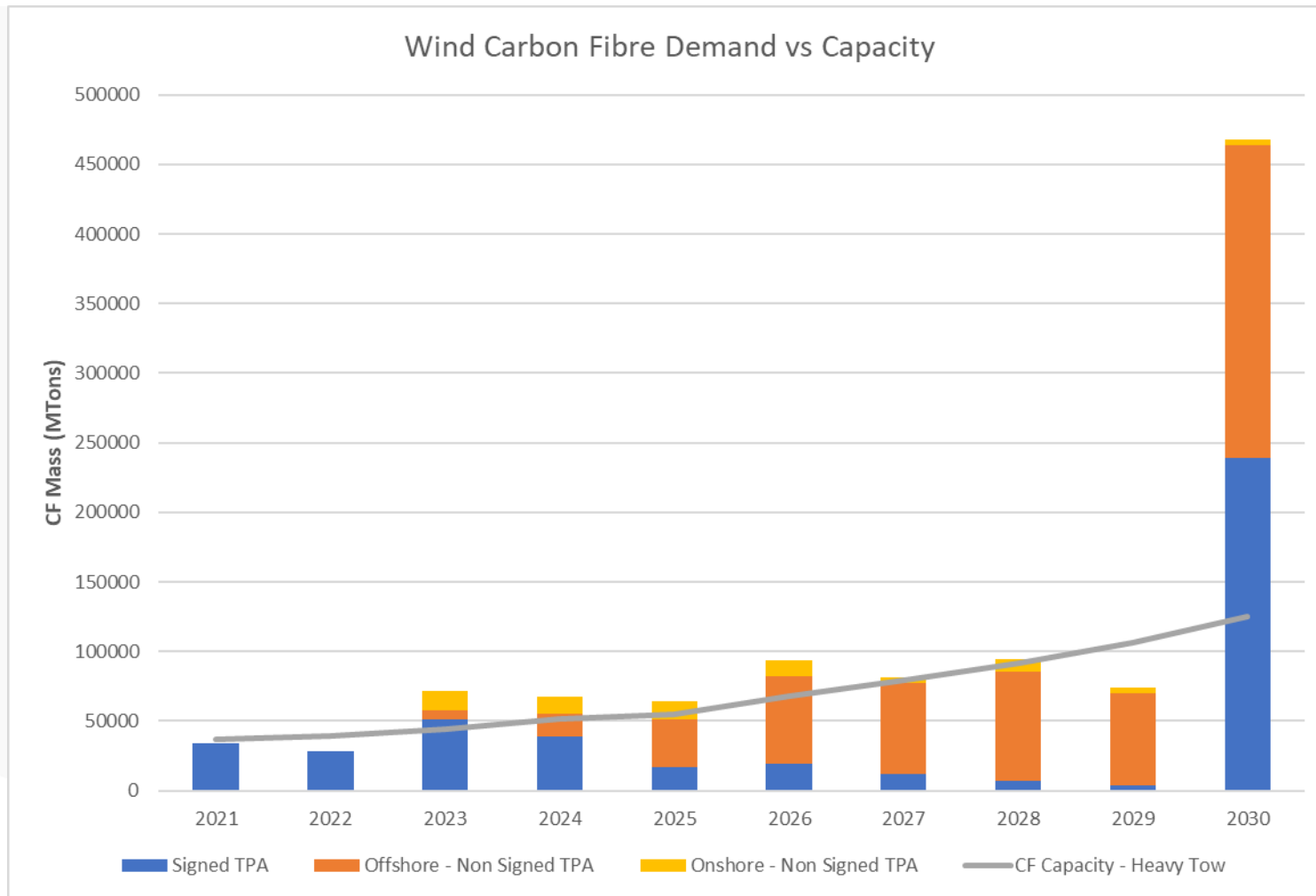
- Global sourcing
- Continue raw materials commoditisation

**2021/2022**



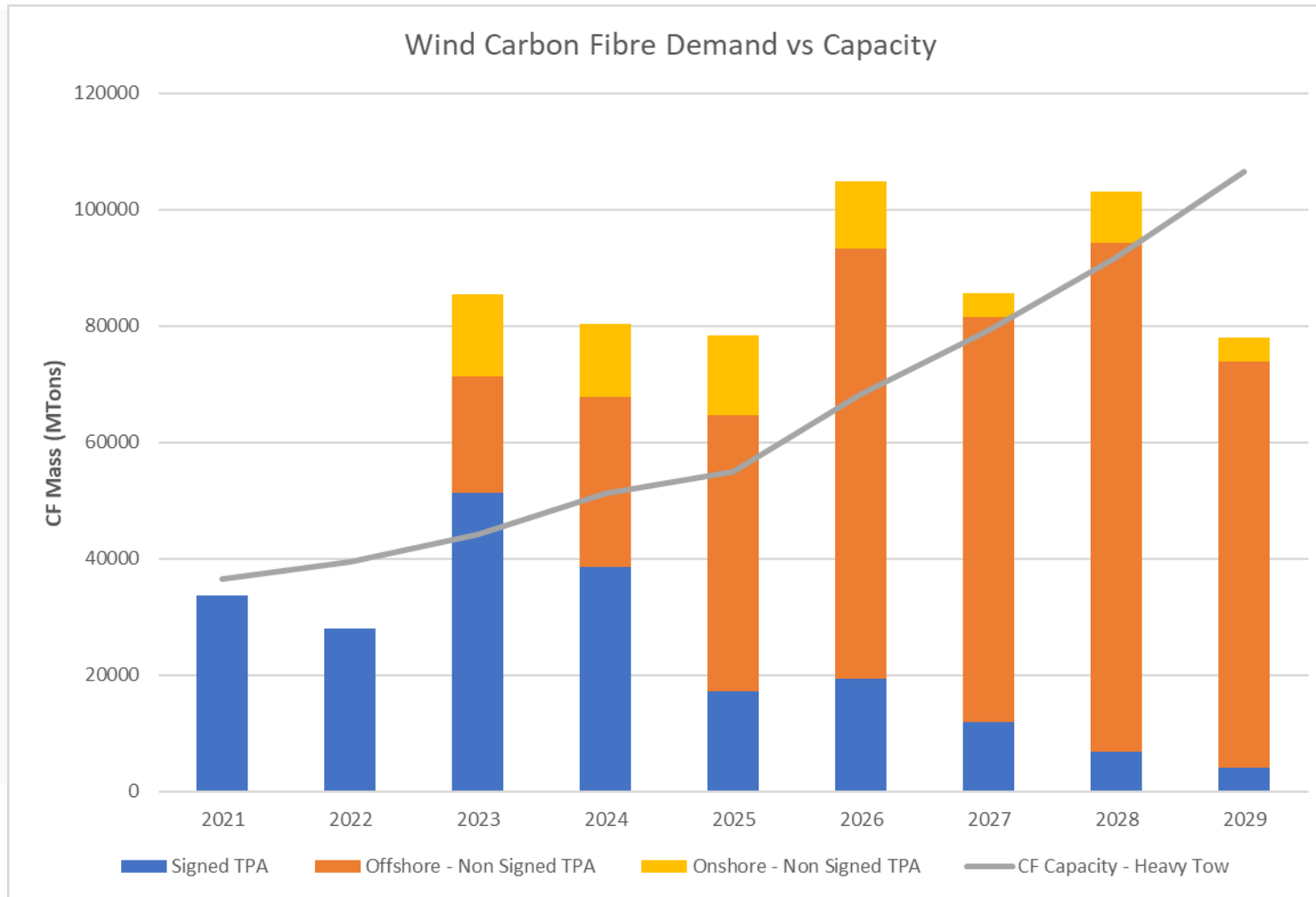
- Long term contract with material suppliers
- Managing future shortage

# Carbon Fibre Supply and Demand



- All Offshore blades use CF
- Onshore blade CF use limited to current users
- Order Book and TPA Source:
  - Wind Power Monthly
- An optimistic heavy tow CAGR = 15%

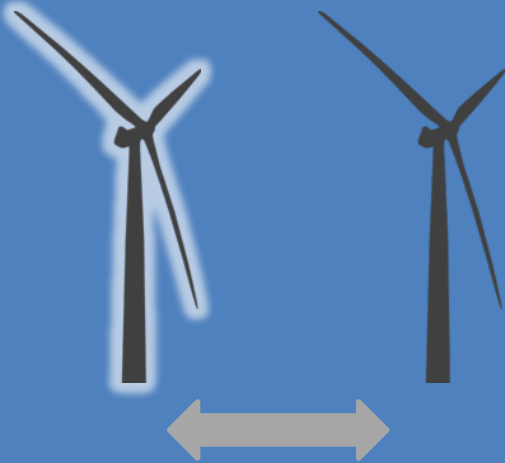
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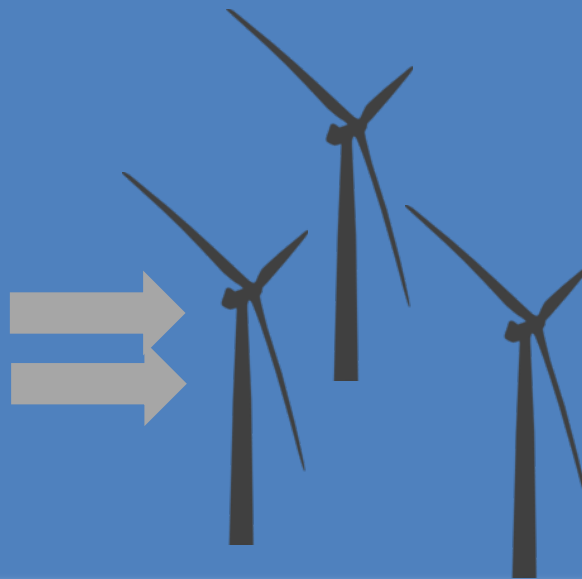
## Scenario F1

Sparcap technology remains unchanged



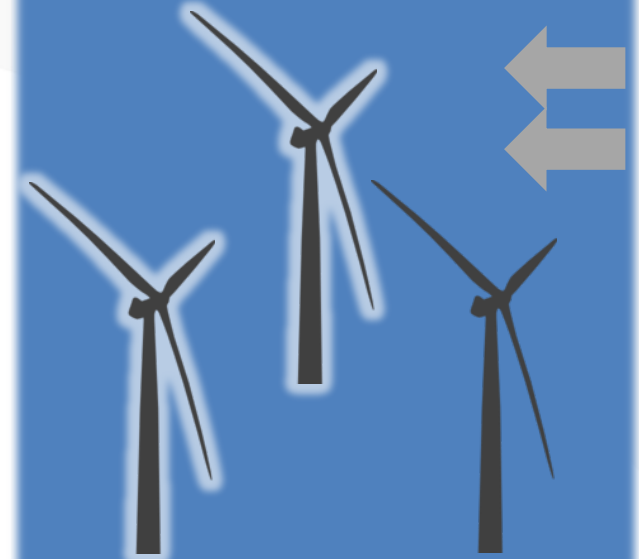
## Scenario F2

All blade sparcaps use Carbon Fibre in 2030

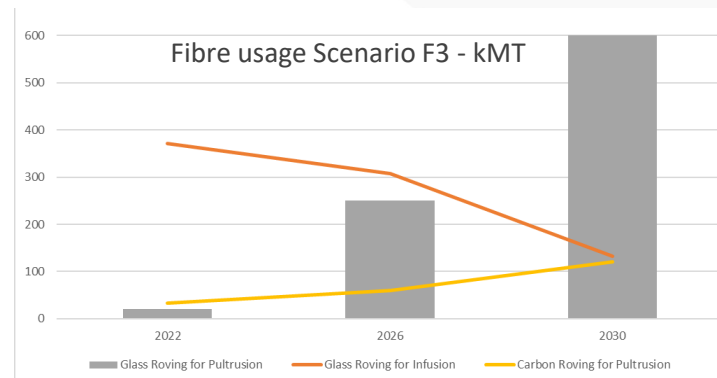
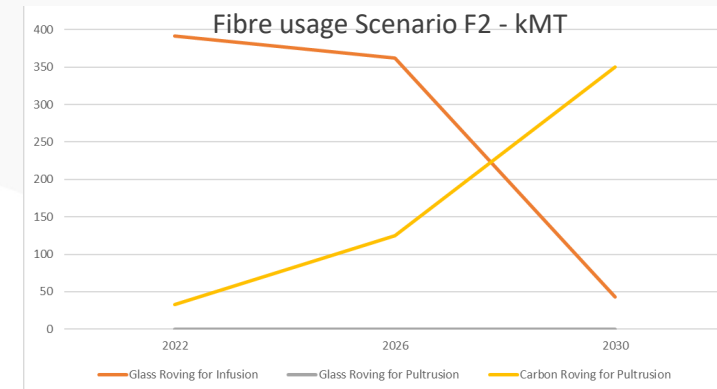
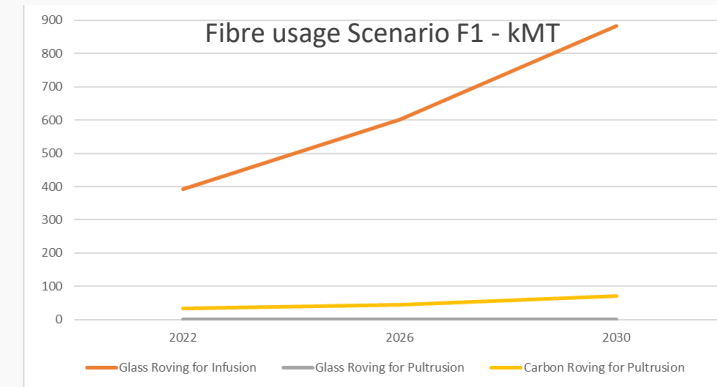

















## Scenario F3


Multi material environment with Pultrusion



- Scenario F1: Sparcap technology remains unchanged
  - ⊗ Blade weight may become problematic
- Scenario F2: All blade Sparcaps use carbon fibre in 2030
  - ⊗ Requires CAGR of 34% until 2030 for carbon fibre global capacity
- Scenario F3: Multi material environment with Pultrusion
  - ⊗ Glass Pultrusion displace glass infusion as sparcap technology
  - ⊗ Carbon fibre covers the needs of the offshore sector and existing onshore



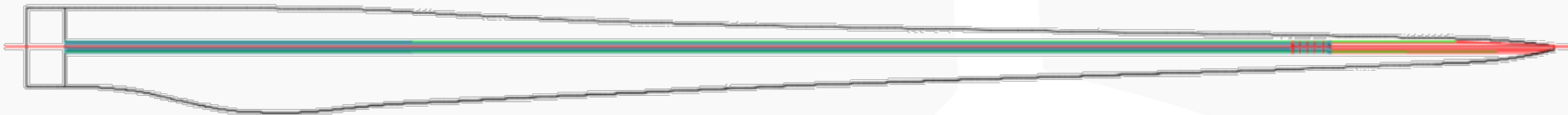
	2030		
	Scenario F1	Scenario F2	Scenario F3
Managing fibre shortages			
Pultrusion supply chain maturity			
Technology readiness			
Blade weight			
Bill of Material cost			

 [World Pultrusion Conference 2022 – ‘Advances in Pultrusion for Wind Turbine Blades’](#)  
CLICK HERE



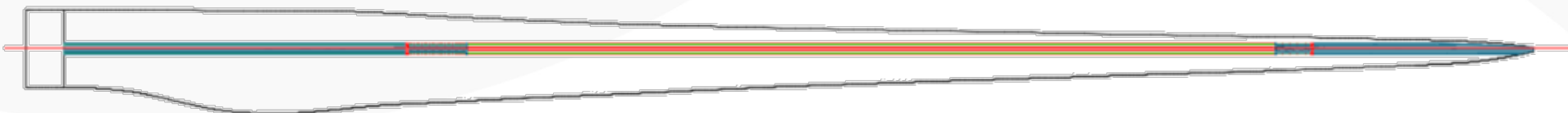
### a) Single Material Spar Cap

- Blade Weight Glass Infused – 36,867 kg
- Blade weight Glass Pultrusion – 35,907 kg
- Blade Weight Carbon – 25,763kg (5,182kg of CFP)



### b) Multi-Material Spar Cap #1

- Blade weight Glass-CF Pultrusion 35,480 kg (258 kg of CFP)  
=> Reduces CF usage by 95%

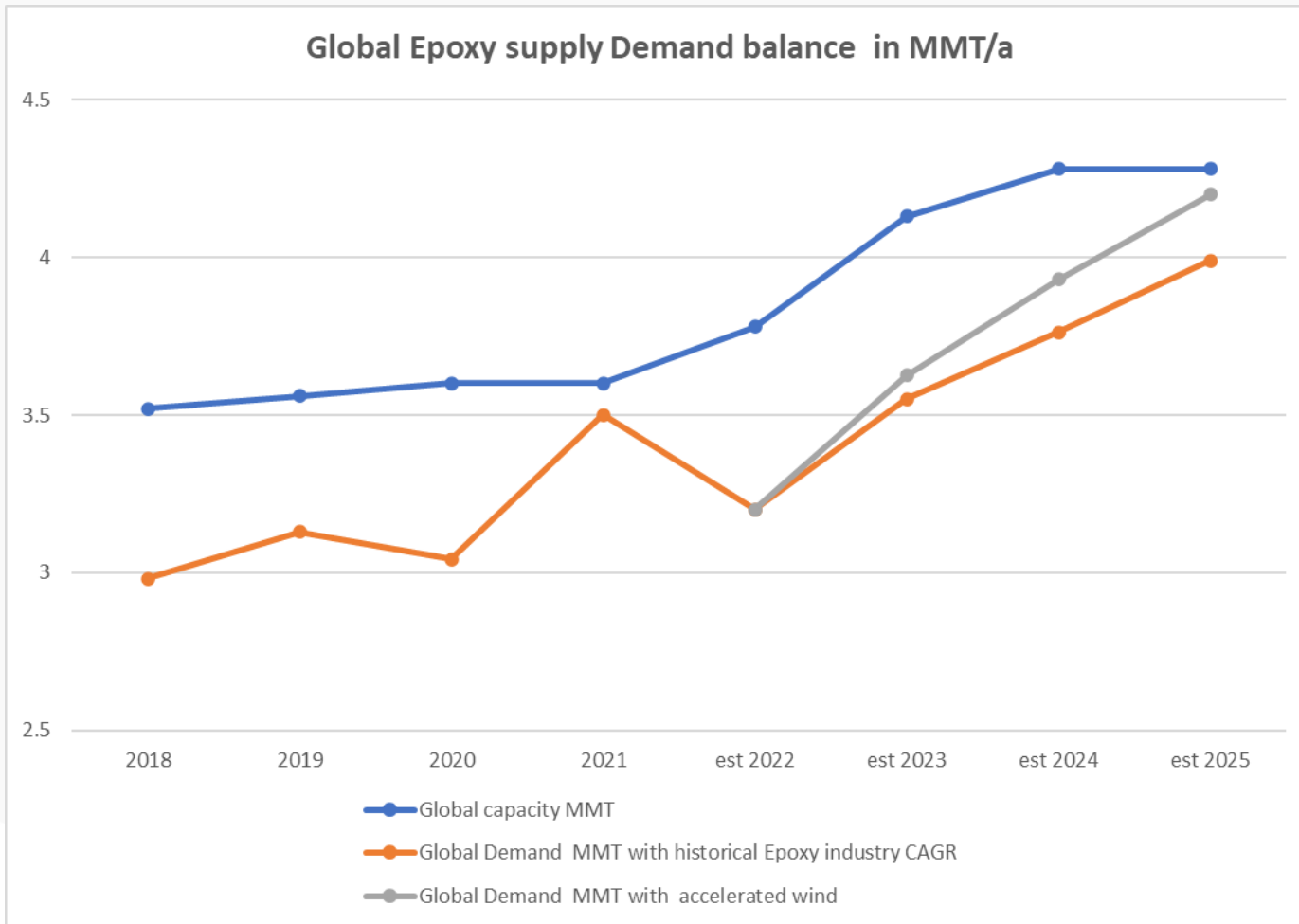


### c) Multi-Material Spar Cap #2

- Blade weight Glass-CF Pultrusion 27,949 kg (3,116 kg of CFPs)  
=> Reduces CF usage by 40%

STRUCTeam Patent:  
UK Patent Application 2306812.5

# Epoxy Supply and Demand

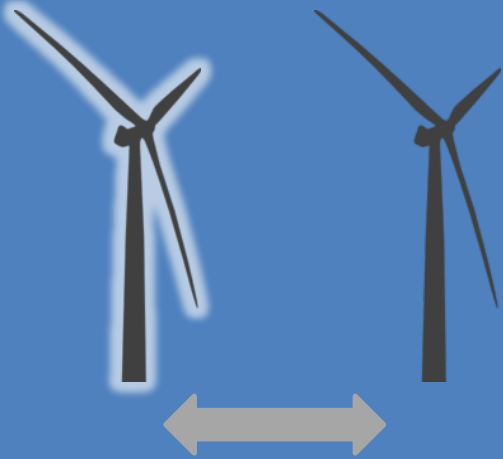


Geographic disparity in new capacity additions



## Scenario R1

Epoxy/Polyester as standard



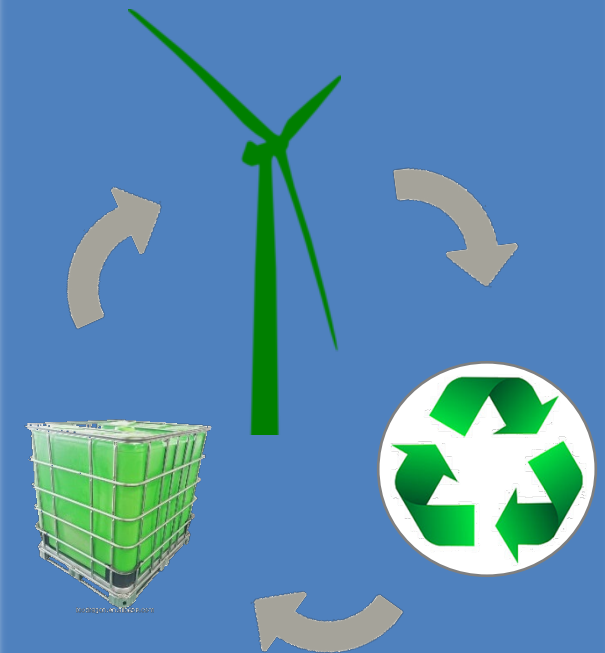
## Scenario R2

Multi resin solutions

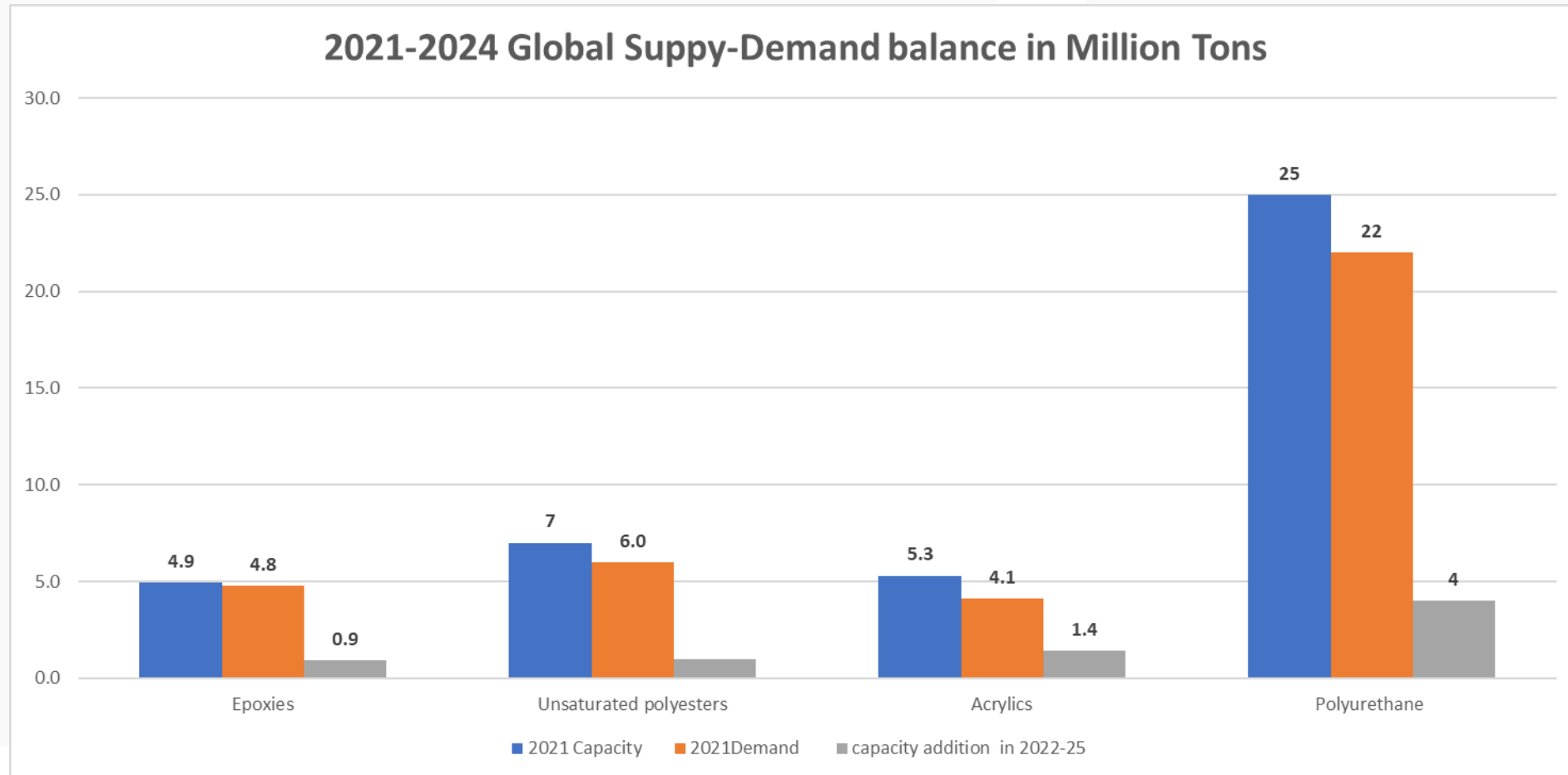


## Scenario R3

Managed end of life

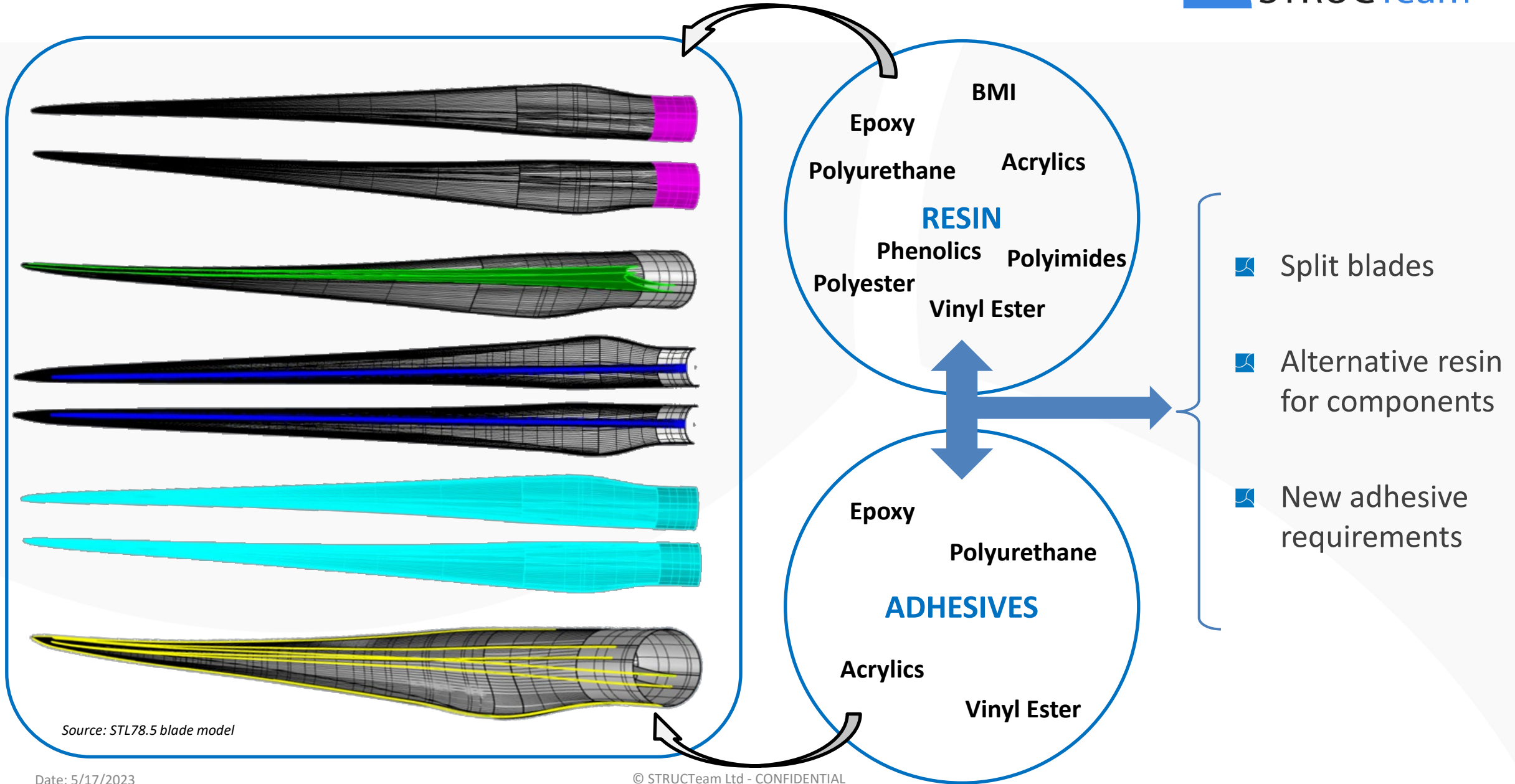


# Availability of Other Polymers

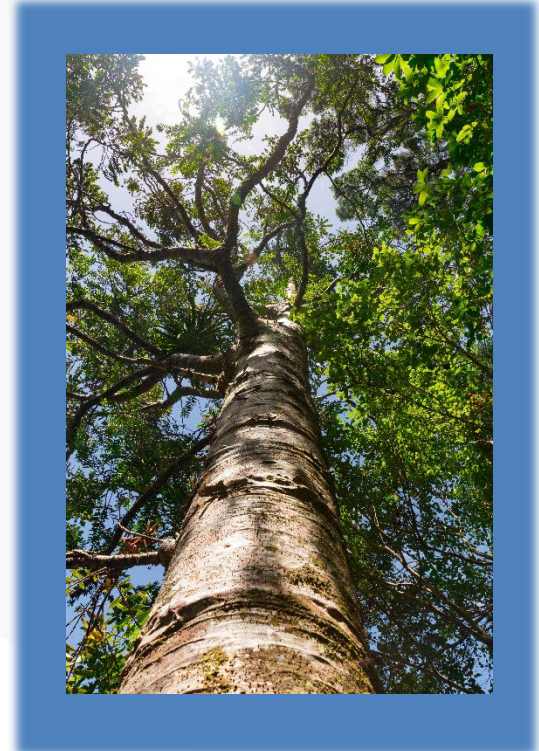
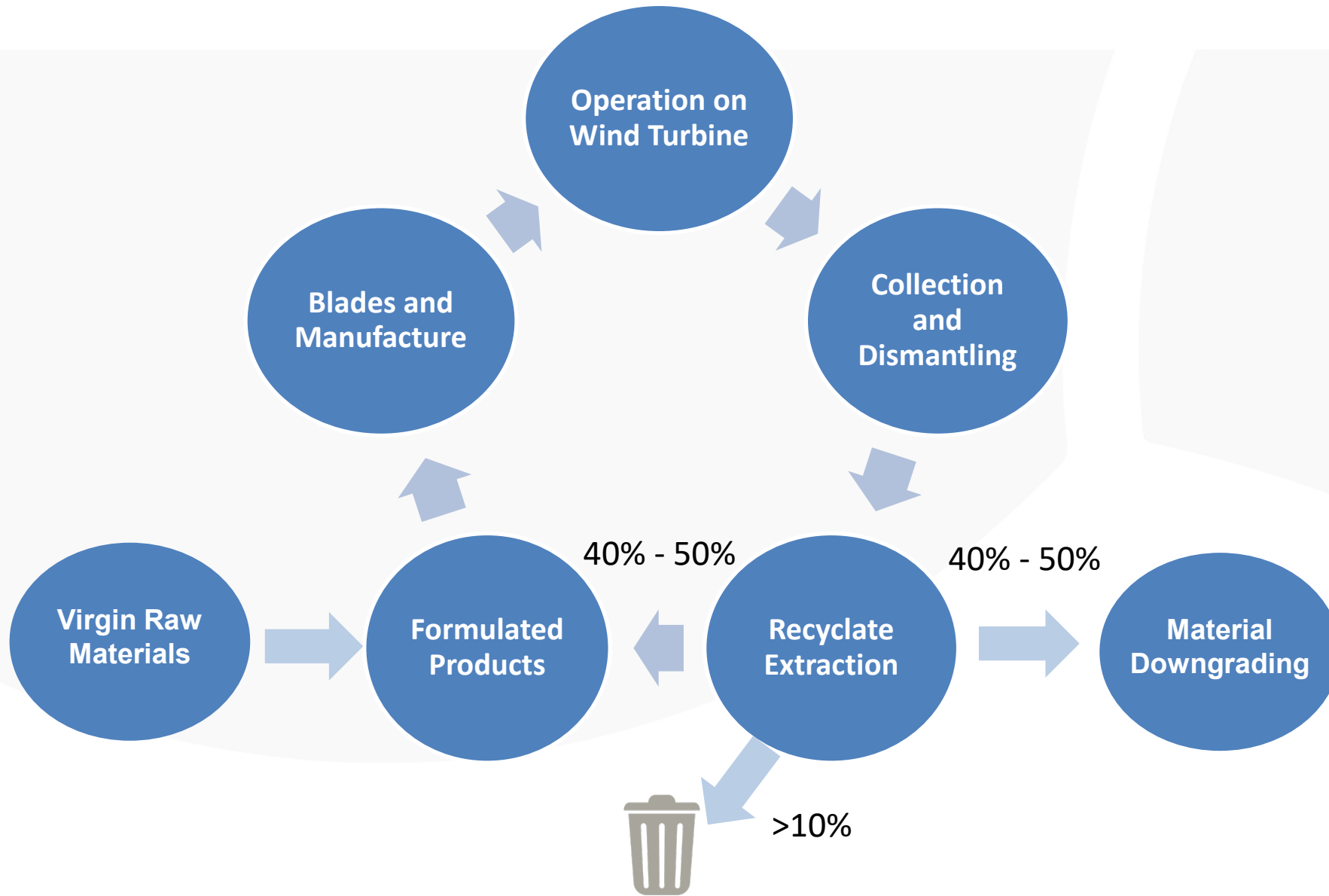


Western capacities growth focussed on Acrylics and Polyurethane

# Scenario R2 – Multi Resin Solutions





















# Scenario R3 - Blade End of Life Management



Unclear green targets are an opportunity to set standards

# Risk Analysis for Resin Scenarios

	2030		
	Scenario R1	Scenario R2	Scenario R3 - EoL
Resin supply security			
Resin technology maturity			
Blade weight			
Future green regulations			
Bill of Material cost		 	  

# Conclusion

- Long term alignment between OEM's, material suppliers and pultruders:
  - ✘ Great carbon fibre demand, likely to be allocated to offshore
  - ✘ Great future for high modulus glass for both onshore and offshore
  
- OEM's need to keep a proactive focus on R&D and qualification programs for alternative resins:
  - ✘ Blades are likely to adopt multi resin solutions to meet the expected yearly GW
  - ✘ Unknown future regulations on end of life are an opportunity to set tomorrow's standards
  
- Pultrusion has a key role to play to support the Wind sector expected growth



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