

# Torayca Carbon Fibre for wind turbine blade



16<sup>th</sup> / Mar / 2010

**TORAY**  
Innovation by Chemistry











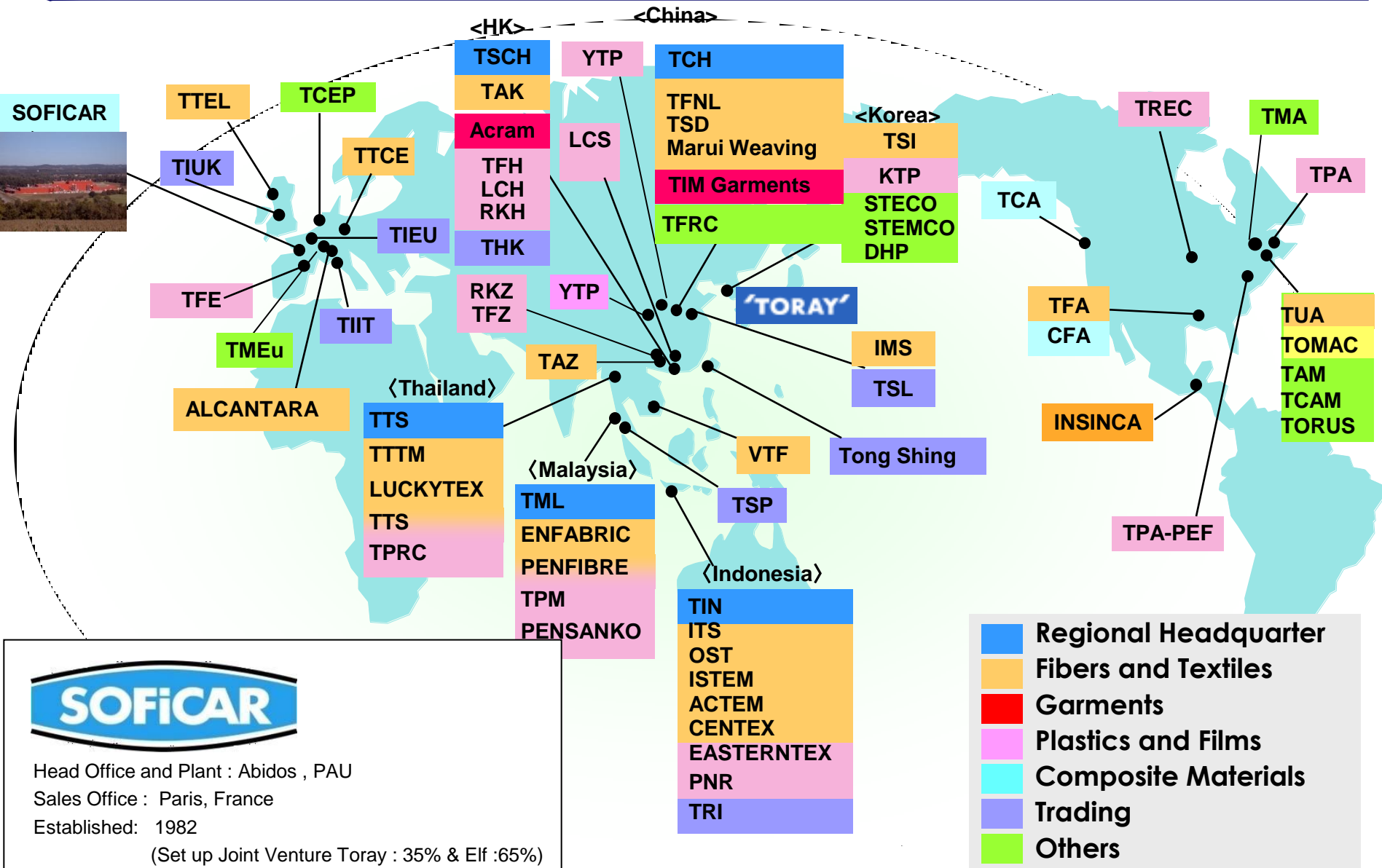
# Introduction of TORAY Group activity

## - Sales by Business Category and Business Segment

Establishing stable profit base with Foundation Businesses, Toray works to improve profitability through the expansion of Strategically Expanding Businesses, and nurture Strategically Developing Businesses where we expect future growth.

<Business Segments>	<Major Products>	Net Sales (Mar/09)	Million US\$ (US\$=JPY100)
Fibers and Textiles		5,690 (39%)	
Plastics & Chemicals		3,776 (26%)	
Foundation Businesses			
IT-related Products		2,294 (16%)	
Carbon Fiber Composite Materials		704 (5%)	
Strategically Expanding Businesses			
Environment & Engineering		1,602 (11%)	
Life Science & Other Businesses		649 (4%)	
Strategically Developing Businesses			
Total		14,716	

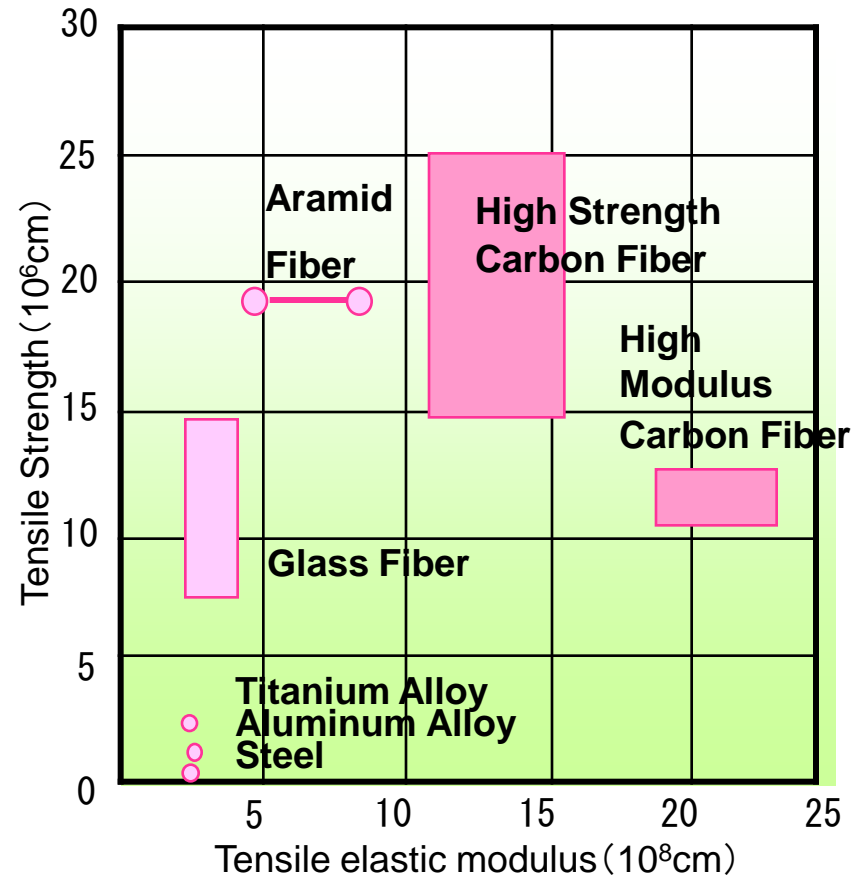
# SOFICAR in TORAY's global network



Head Office and Plant : Abidos , PAU  
 Sales Office : Paris, France  
 Established: 1982  
 (Set up Joint Venture Toray : 35% & Elf :65%)  
 Activity : Manufacturing carbon fiber and composite  
 Representative of TORAY ACM Div in Europe

# Feature of Carbon Fibre

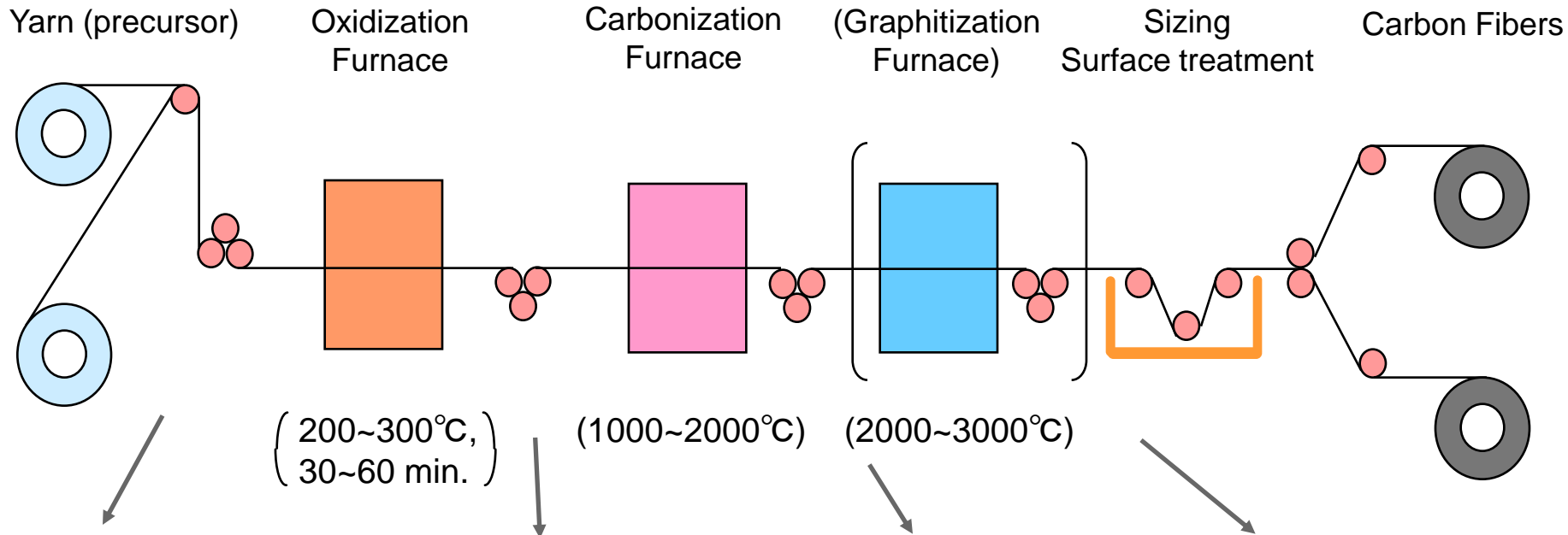
1. Light Weight: 1/4 of Steel  
(Specific Gravity)
2. Strength: 10 times of Steel  
(Specific Strength)
3. Rust Less
4. Others
  - Radio Lucenty
  - Chemical Resistant
  - Thermal Resistant
  - Thermal Stability
  - Fibrous Form (Processibility)



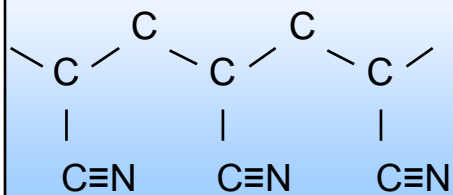
**Tensile strength:** The strength of material expressed as the greatest longitudinal stress it can bear without tearing apart

**Tensile elastic modulus:** The ratio of the applied stress to the change in shape of an elastic body

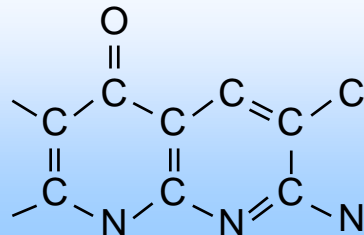
# Manufacturing Process of Carbon Fibre



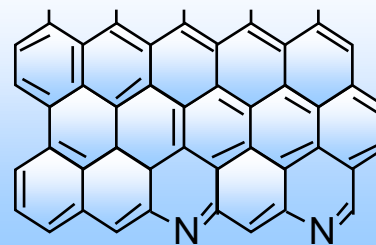
PAN Precursor



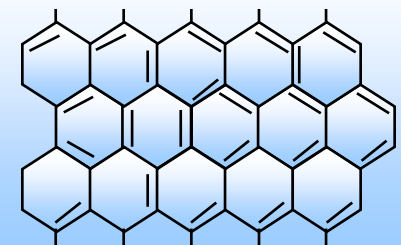
Oxidized fiber



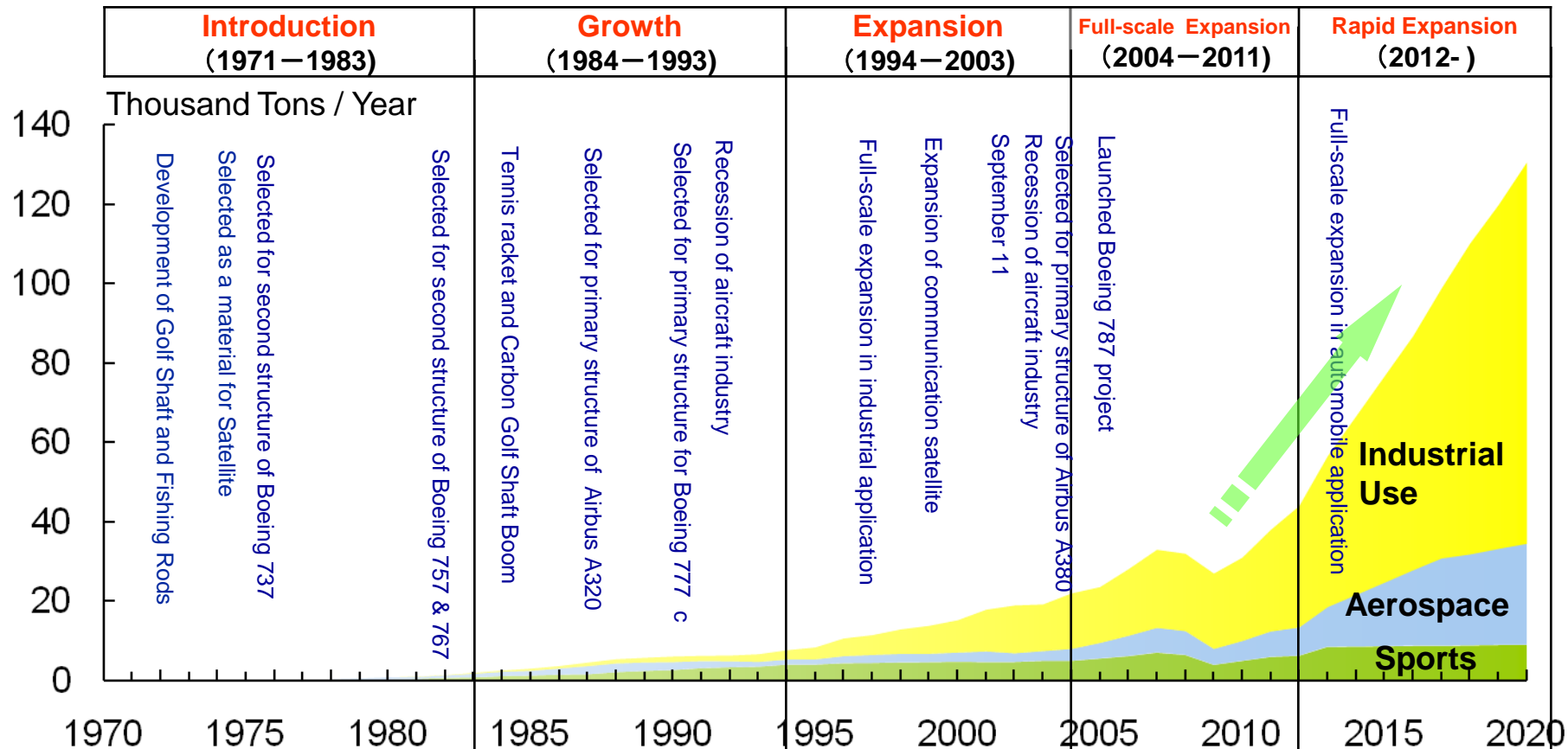
Carbon Fiber



Graphitized Fiber

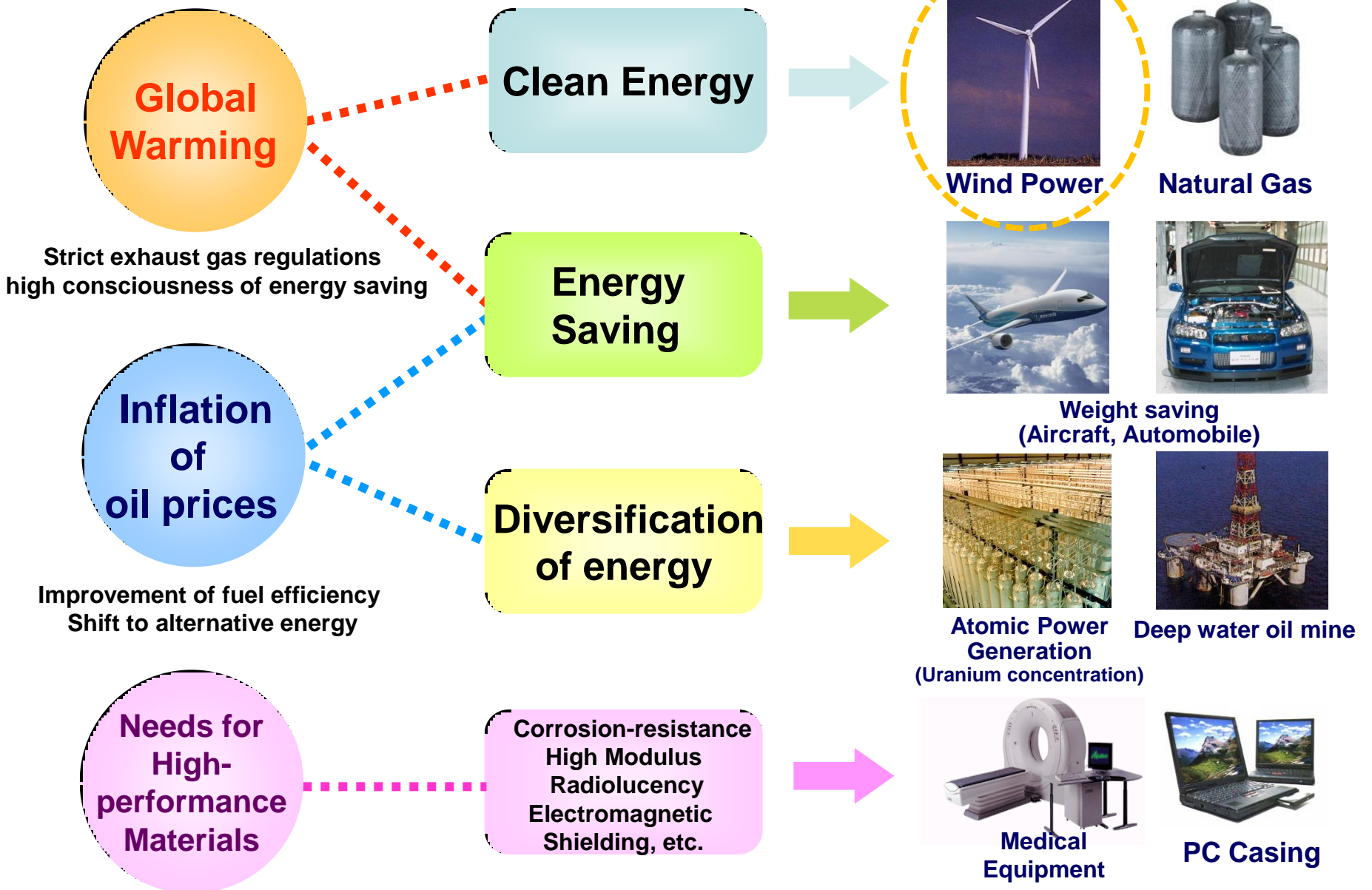


# Carbon Fiber Market transition



	Introduction (1971-1983)	Growth (1984-1993)	Expansion (1994-2003)	Full-scale Expansion (2004-2011)	Rapid Expansion (2012-)
Main Application	<b>Limited Field</b> Fishing rods Aircraft secondary structure	<b>Increase in application</b> Tennis rackets Golf Shafts Aircraft primary structure	<b>Increase in Industrial Use</b> Pressure vessel Machine parts Engineering, Marine	<b>Full-scale increase in Aircraft and Automobile</b> Large aircraft program Wind blade Automobile, Oil mine	
Remarks	High Quality	Increase of product type Progress in molding technology	Cost reduction Large scale structure	Variety in molding method Recycle of Carbon Fibers	

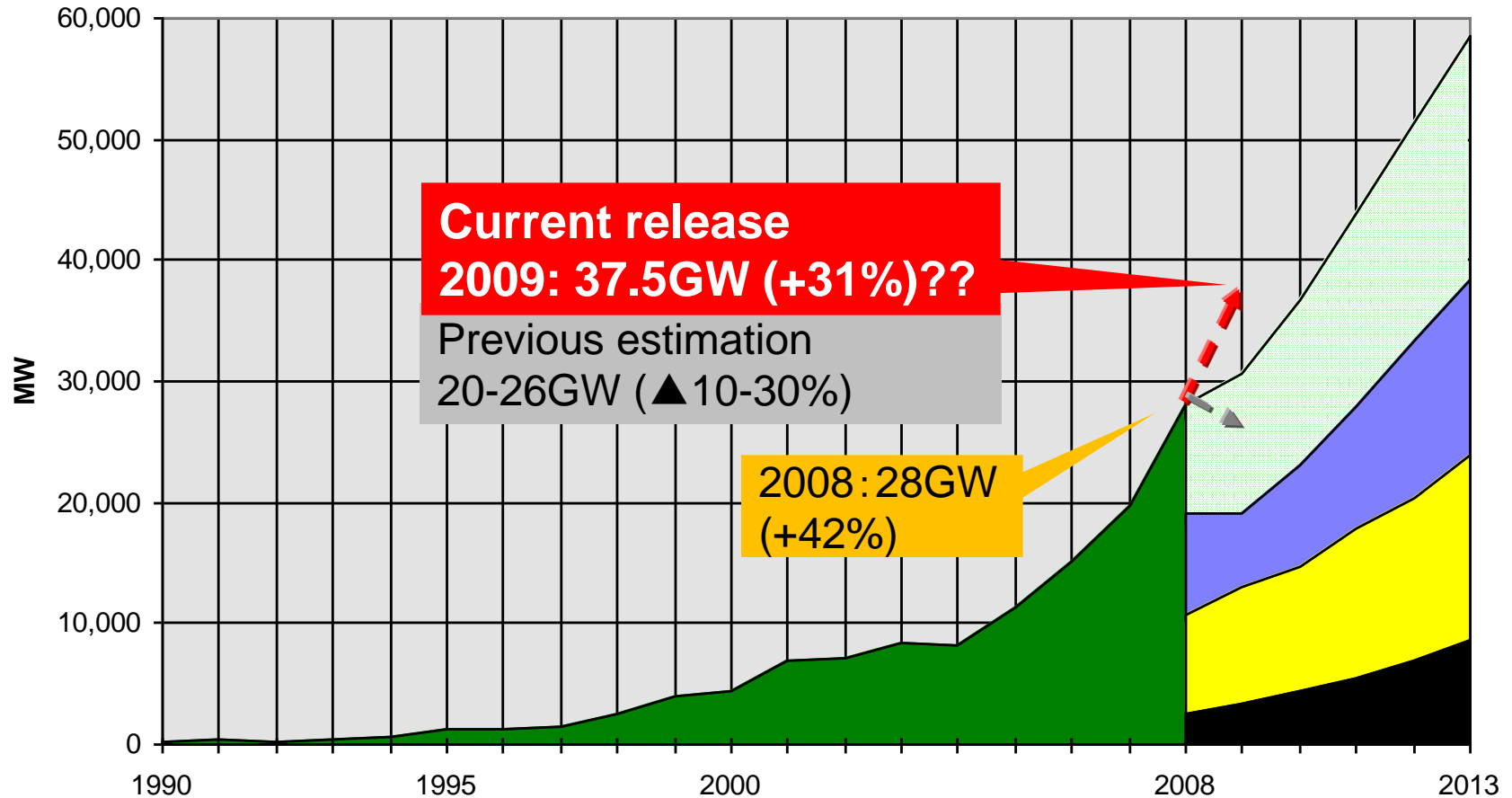
# Business environment of Carbon Fibers



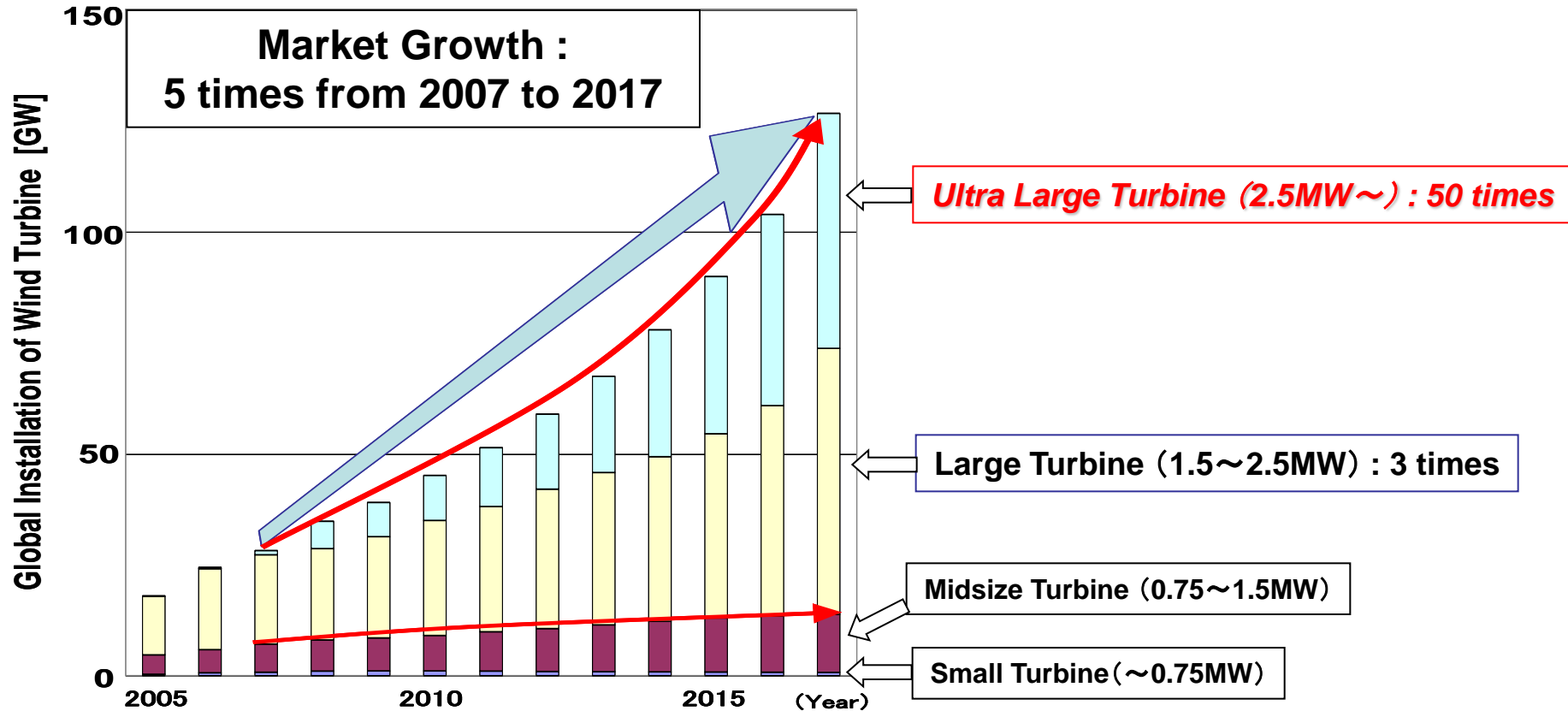
# Market Demand Forecast (latest Info)

## Annual Wind Power Development

Actual 1990-2008 & Forecast 2009-2013



# Tendency of Wind Turbine Market



Ref. Composites Industry Monthly (March 2008)

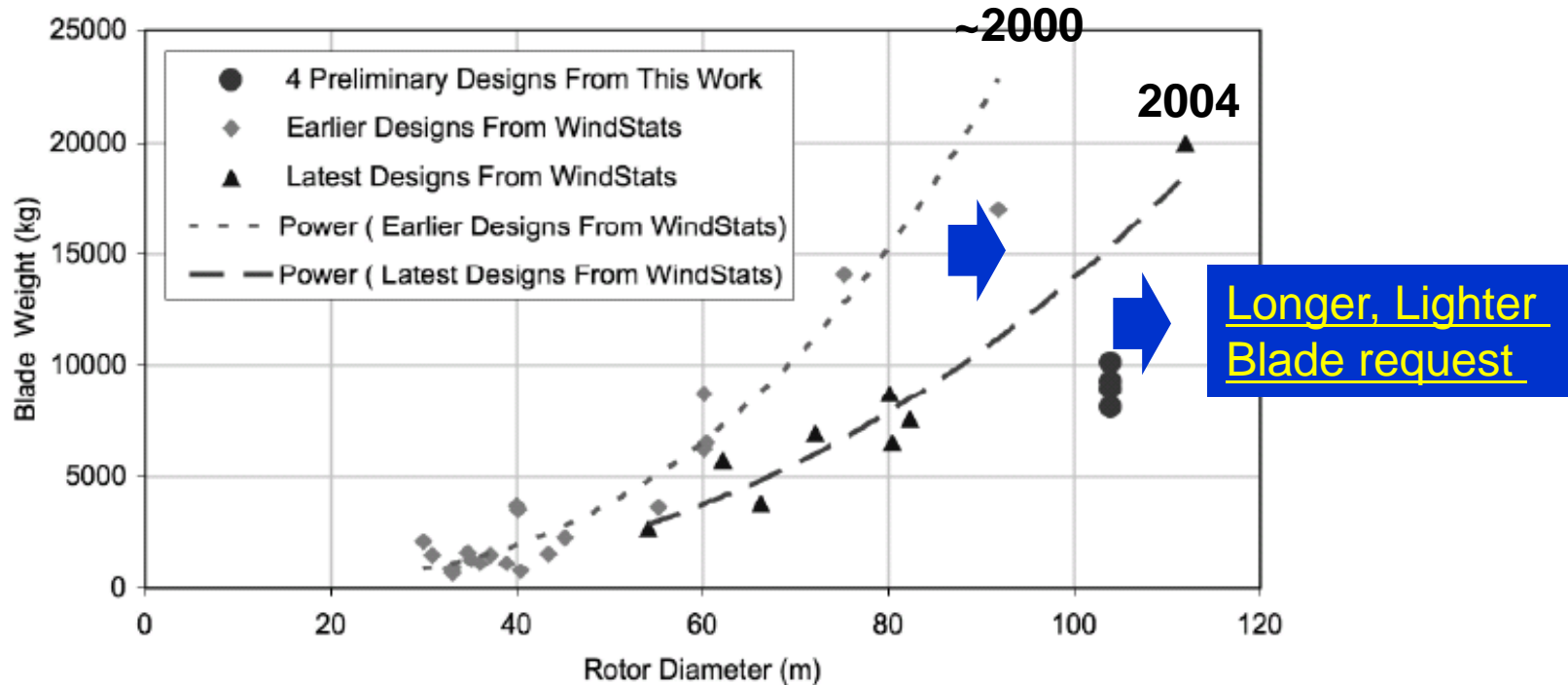
**Large Rotor Blade is required, and consequently,  
Weight Reduction of Blade will be essential.**

# State of arts

SAND 2004-0074 printed May 2004 (Sandia National Laboratories)

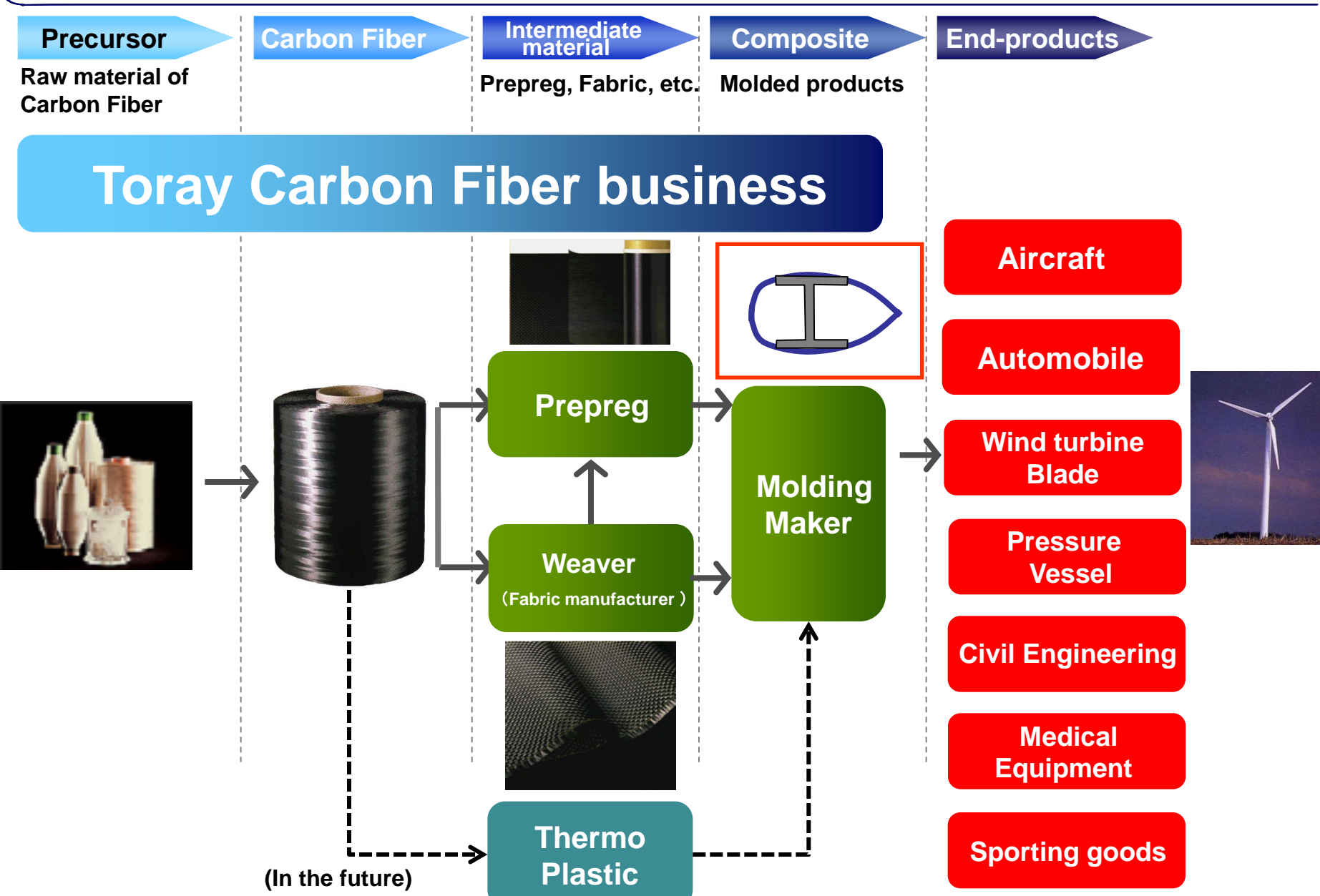
INNOVATIVE DESIGN APPROACHES FOR LARGE WIND TURBINE BLADES FINAL REPORT

WindPACT Blade System Design Studies, TPI Composites, Inc.A



- Key Technologies;
  - a. Structural Design
  - b. Material Technology ← Toray's Mission
  - c. Manufacturing Technology

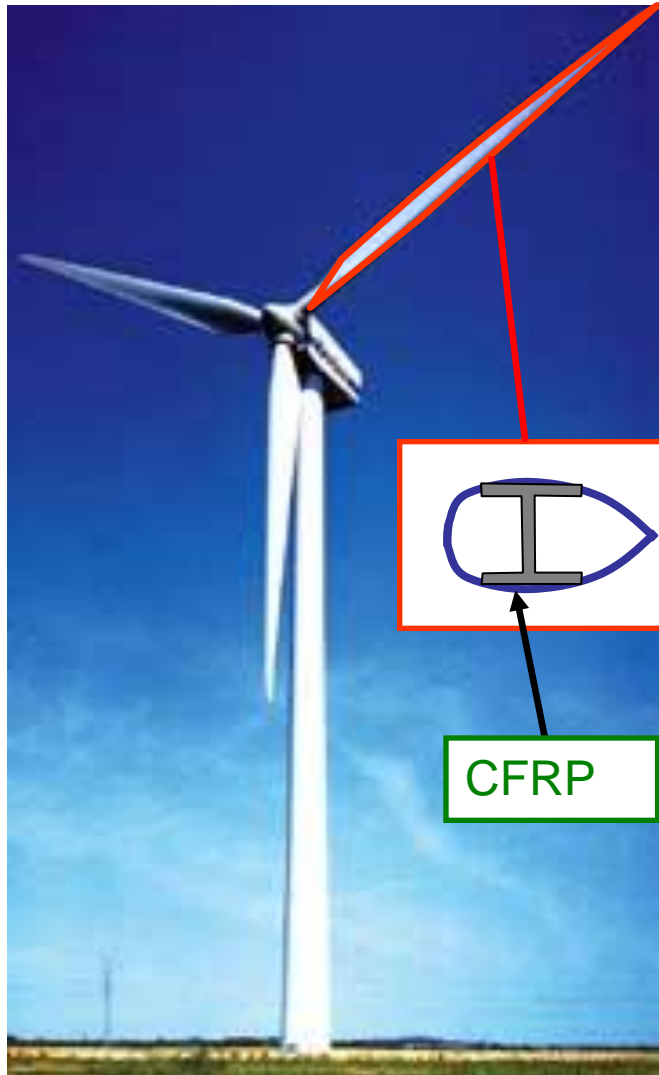
# Fabrication from carbon fiber to wind turbine blade



# Advantage of carbon/glass hybrid blade

## Light weight carbon/glass hybrid blade

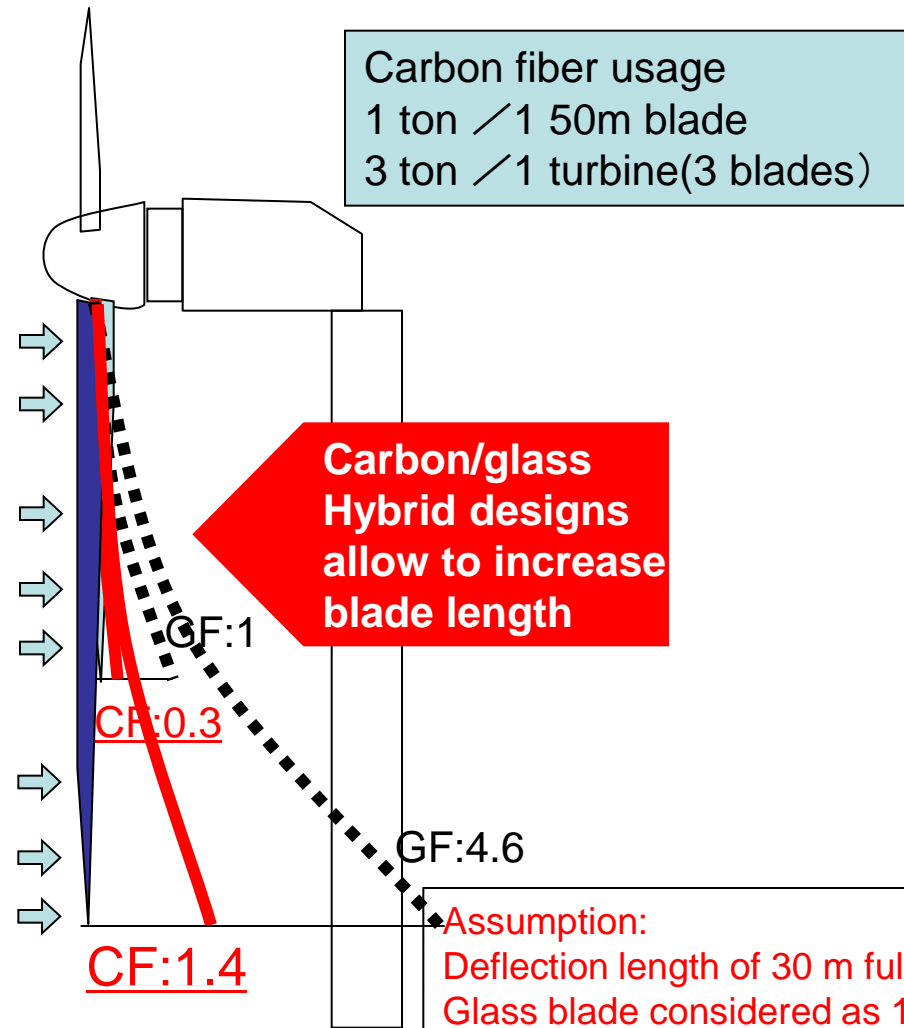
- ① High efficiency of generating cost
- ② Stiff carbon composite reduce deflection
- ③ Weight reduction for total cost down



CFRP

1.5MW  
30m length

4MW  
50m length



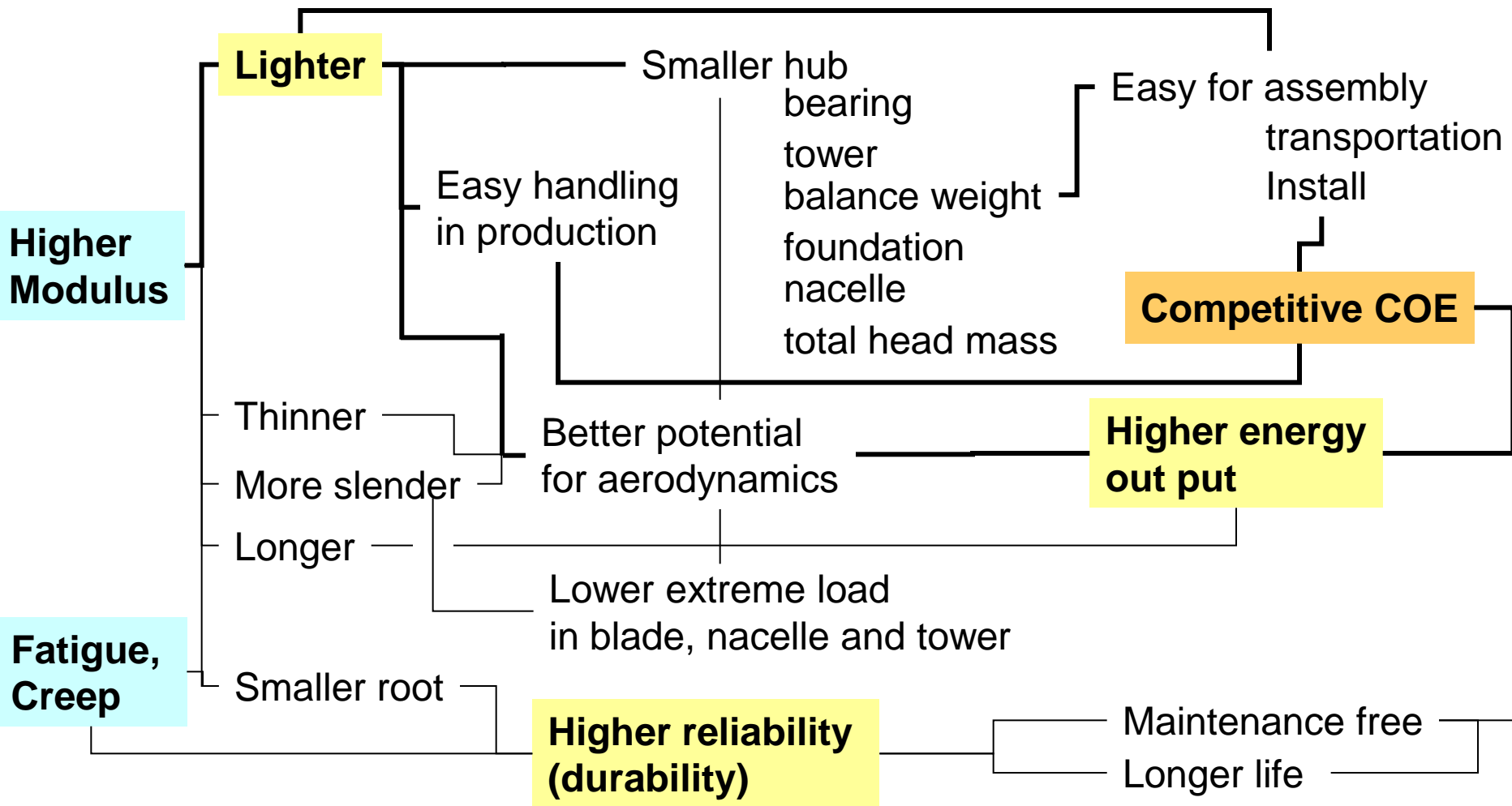
# Advantage of CF usage to Blade



CF

Blade

Turbine



$$COE = \frac{COSTS \propto \text{weight} \propto r^{2.8}}{ENERGY \propto \text{area} \propto r^2}$$

**Gracias por su atencion**

**Merci de votre attention**

**Thank you very much for your attention**



**TORAY**

**Innovation by Chemistry**

