INNOVATIONS FOR LIVING™

COMPOSITE SOLUTIONS

WindStrand™ SOLUTIONS

High-Performance Reinforcements

Reinforcing Wind Energy

C. Van Hoornweder
Eric Dallies
WPA 2009

OCV™ Reinforcements | OCV™ Technical Fabrics | OCV™ Non-Woven Technologies

- The Wind Energy market – going into 2020
- Technology trends: some solutions from OCV

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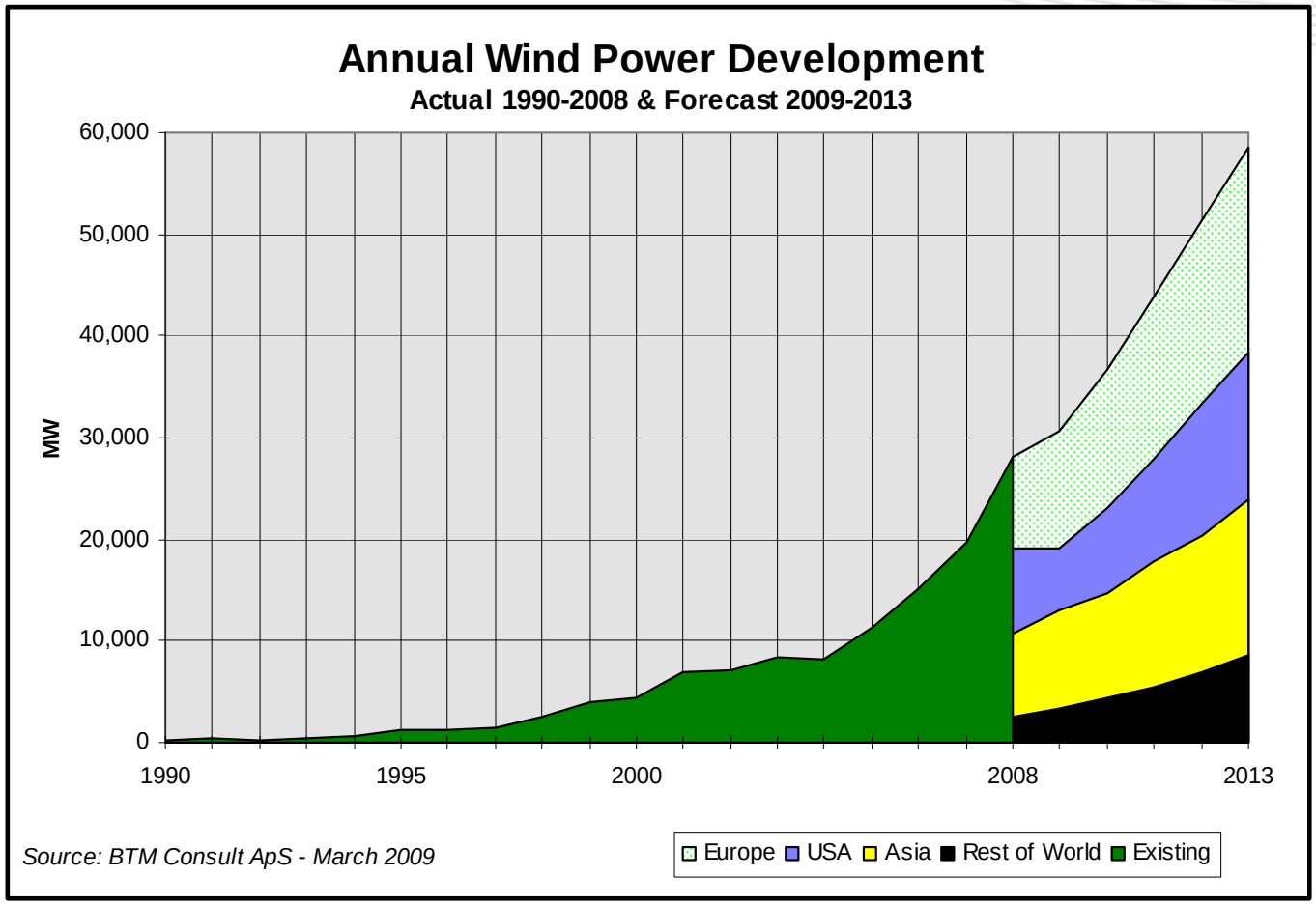
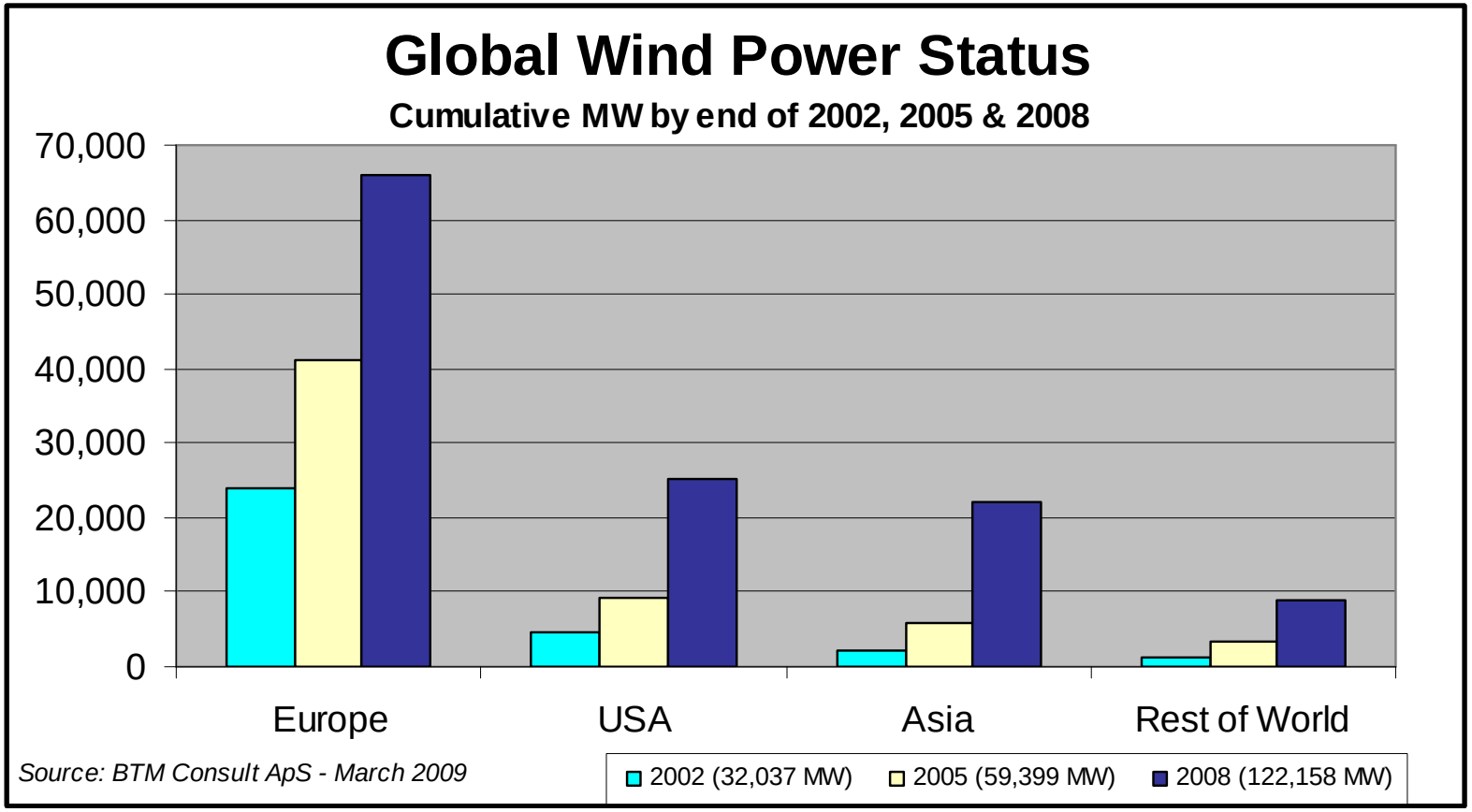
Wind Energy
a sustainable market



Wind Energy
A global market



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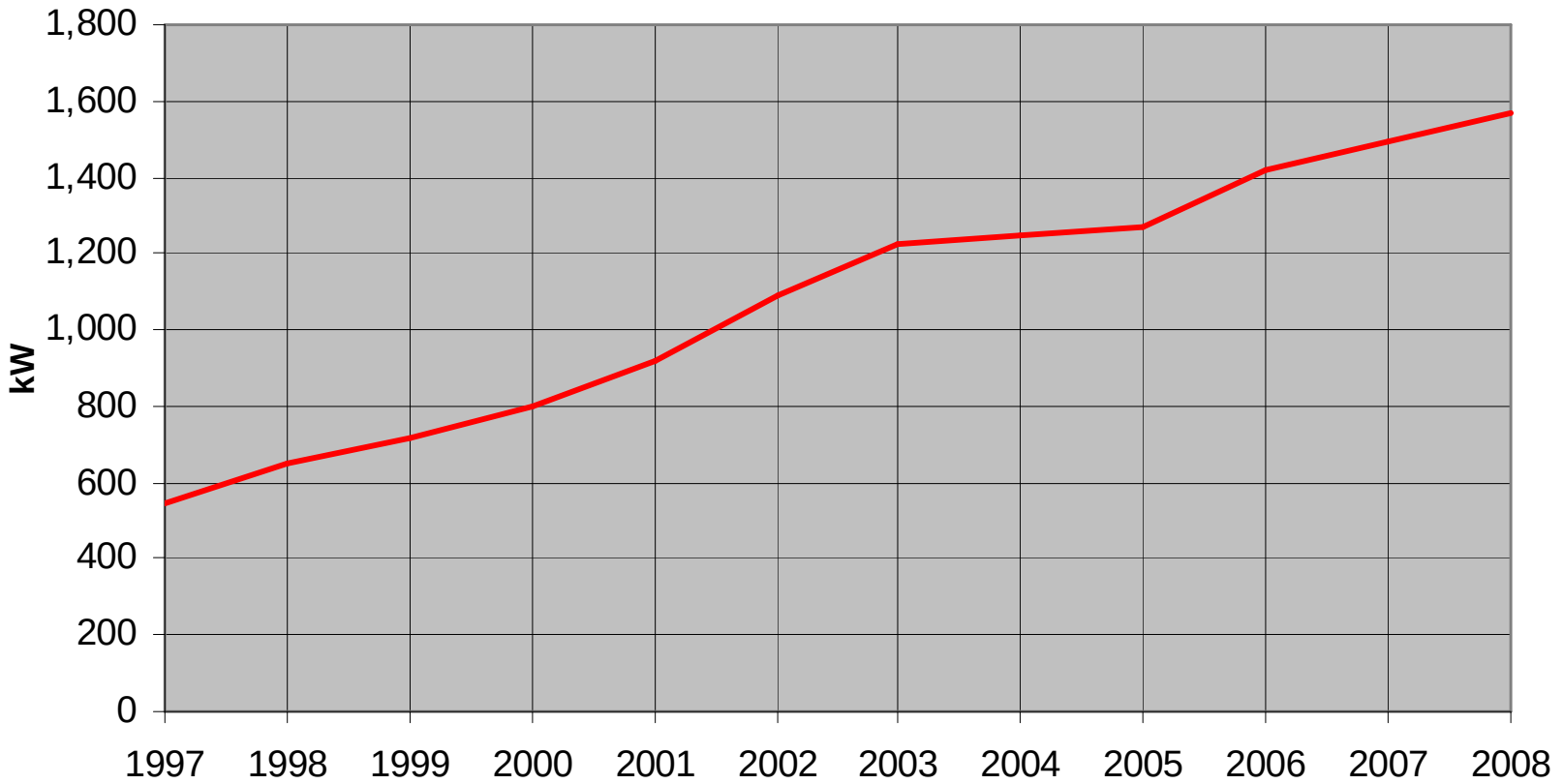
Wind Turbine delivering more power

Global Average Annual WTG in kW

Source: BTM Consult ApS - March 2009



Growth in Wind Turbine size

Product (Size range)	Units	MW	kW/unit	Share
0-749kW	454	153	337	0.5%
750-999kW	3,691	2,926	793	9.4%
1000-1499kW	1,061	1,188	1,119	3.8%
1500-2500kW	14,241	25,149	1,766	80.4%
2501 and up	603	1,866	3,094	6.0%
Total	**20,050**	**31,281**	**1,560**	**100.0%**

Source: BTM Consult ApS - March 2009

- Drivers
  - Increased power per tower and per investment dollar
  - Reduced land availability leading to increase in size of land turbines and offshore installation

Technology Trends and Innovative solutions

TRENDS AND DRIVERS

- > 48 m blades will show how critical design will become
- > 48 m blades will need higher performing raw materials
- Cost reduction/cycle time driven by shorter mould cycle time and improved infusion process

SOLUTIONS

- High performance glass : WindStrand™ reinforcement
- New and customized fabrics designed for quick infusion, fast lay up and an optimized modulus/$ ratio.

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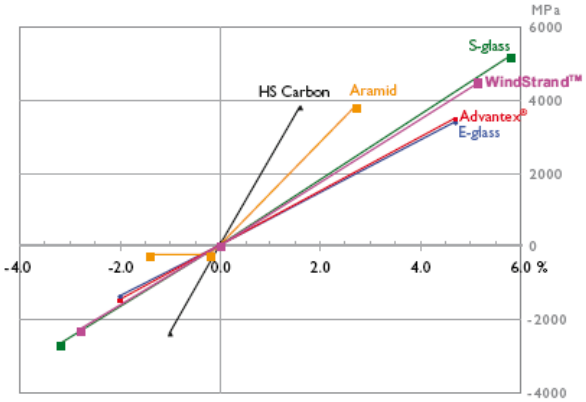
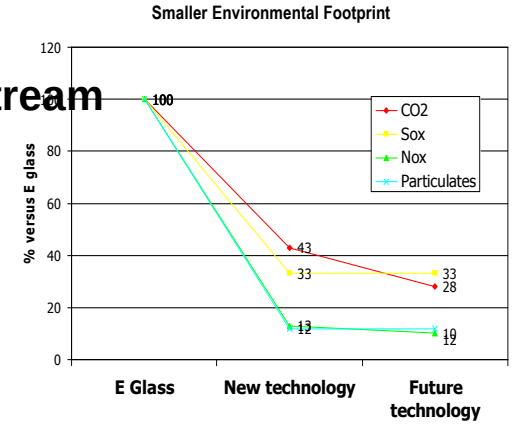
High Performance Glass

- Breakthrough in Advanced Glass Melting Technology
  - **up to 15 % Higher Stiffness (/ E glass)**
  - **Up to 15% increased modulus (/ E glass)**
  - **Up to 10x better fatigue properties (/ E glass)**
- With Environmental Stewardship
  - **Reduced Emissions during Glass Product**
    - **Less Particulate - No Boron**
    - **Less CO_2, NOx, HF**
    - **No Scrubbers => Eliminating Secondary Waste Stream**





Longer Life for Composite Structure

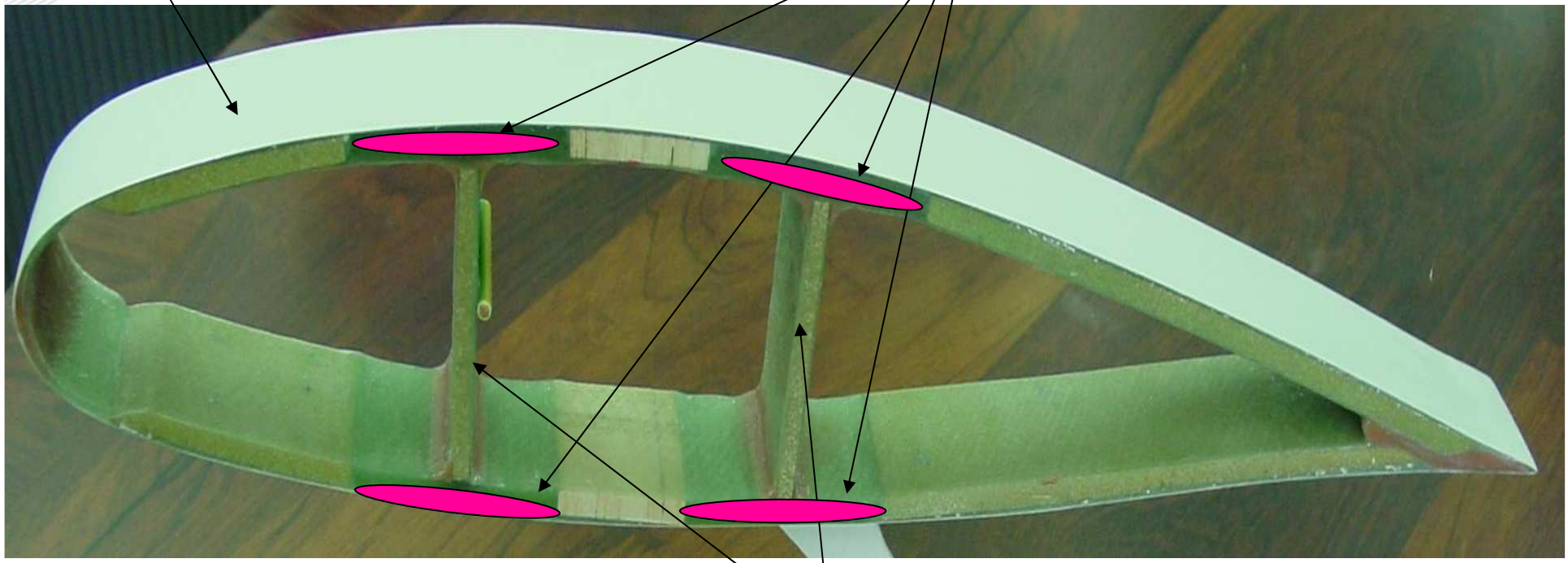
A demonstration of industry leadership

COMPOSITE SOLUTIONS

Main blade parts that could benefit from Windstrand™ Reinforcements

Skins
+-45° or 0+-45° Fabrics

Spar Caps or Girder
0° Fiber or Fabrics



Shear Webs
+-45° Fiber or Fabrics

Ref. SNL, Owens Corning

Mass distribution CTC 44 m blade

How can a stiffer reinforcement be valuable for blade design ?

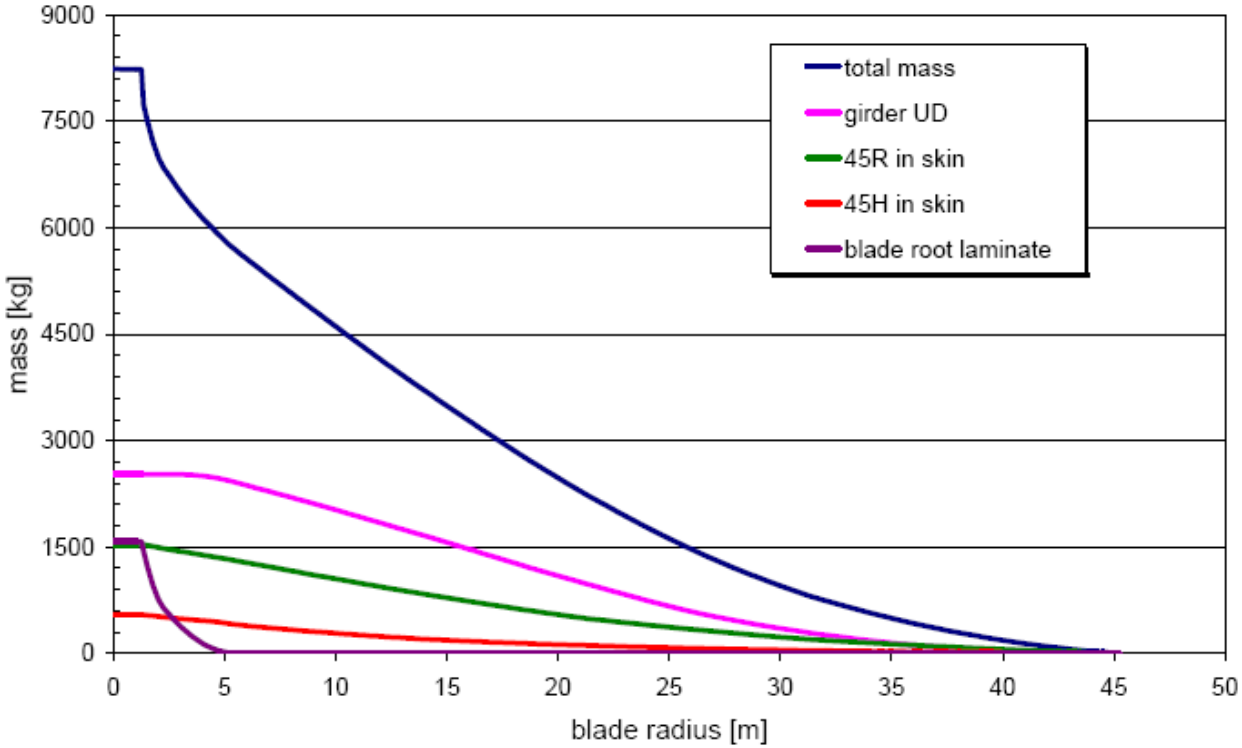


Figure 2: Mass distribution of the baseline blade

To distribute the total mass allowing the blade center of gravity closer to the root join.

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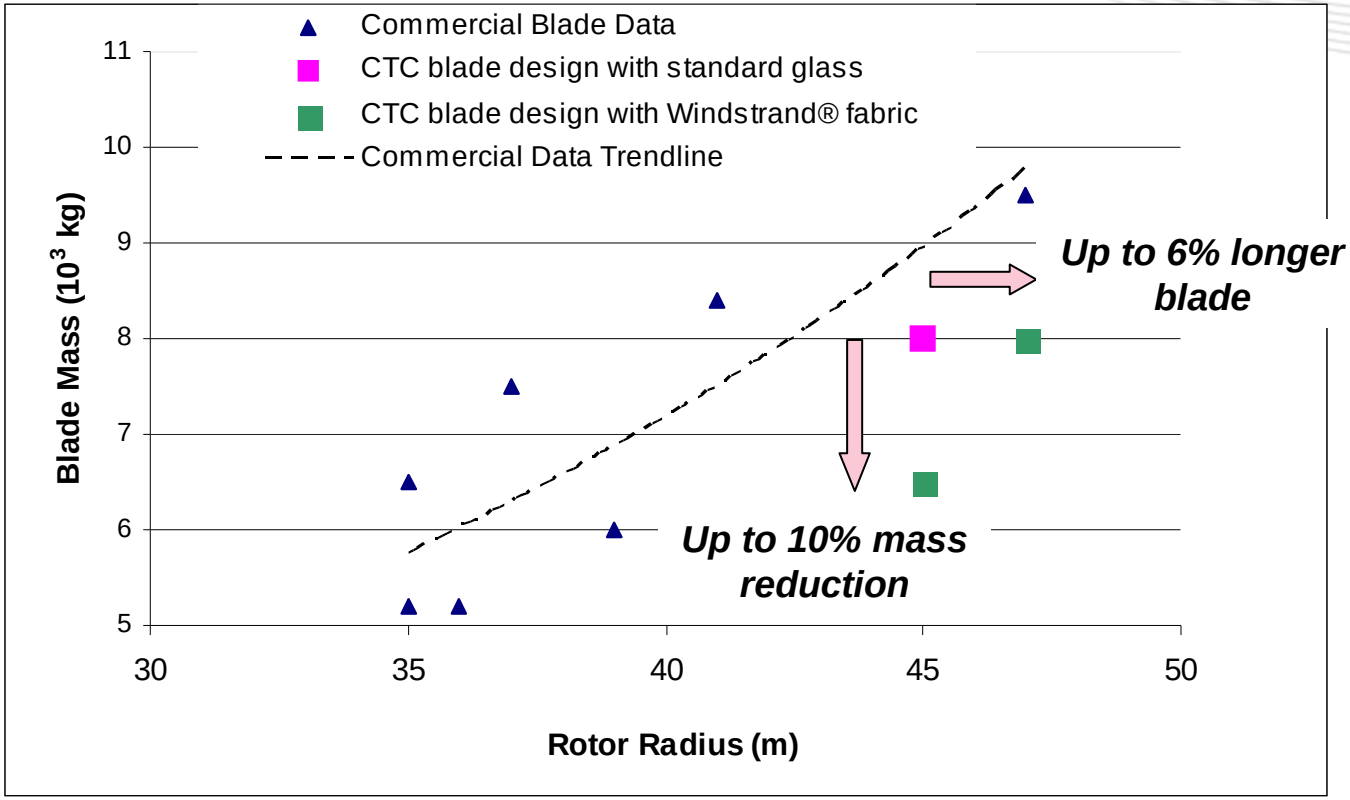
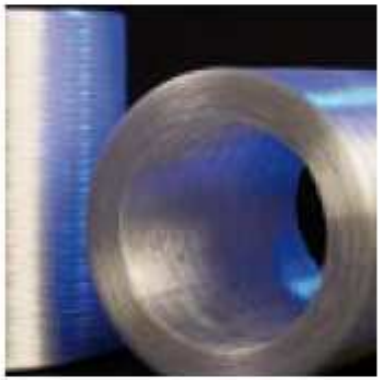
Expected benefits for blade design



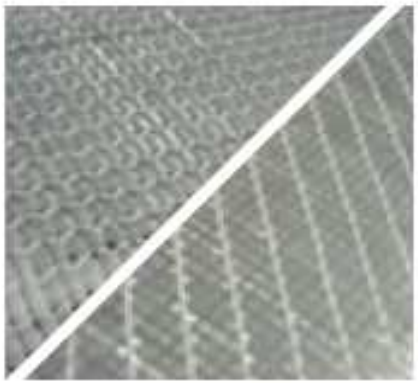
Study performed by the Composite Technology Center

WindStrand™ Higher Stiffness and Fatigue Strength

enables Weight Savings or Longer Blade Design



- Single End Rovings available in Tex ranging from 300 to 2400
- Manufactured using the T30® Roving state-of-the-art technology of Owens Corning



- Multiaxials and Unidirectionals fabrics, specifically designed for quick infusion and fast lay up

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Windstrand™ glass benefits Vs conventional E-Glass

- up to **15 %** Higher Stiffness
  = reduced deformation
- up to **35%** Higher Strength
  = increase load (Higher Wind Speeds)
- up to **50%** higher strain energy density
  = better impact & damage
- tolerance **>10X** enhanced fatigue live (@ same load !)
  = improved reliability,
  = lower maintenance cost, …

What is Coming Next

We are developing <u>WindStrand Plus</u> a new reinforcement product which delivers the performance of the current WindStrand product at lower cost

	2009 S1	2009 S2	2010	2011
WindStrand™	Current Product			
WindStrand Plus		Fabric sample **lab scale**	Fabric sample **industrial scale**	Fabric **commercially available**

- Enables blade manufacturers to improve their stiffness per $ ratio

- Generates more Power from the same turbine

Ultimately resulting in a lower cost per Kwh