

Wind Blade Technologies Overview

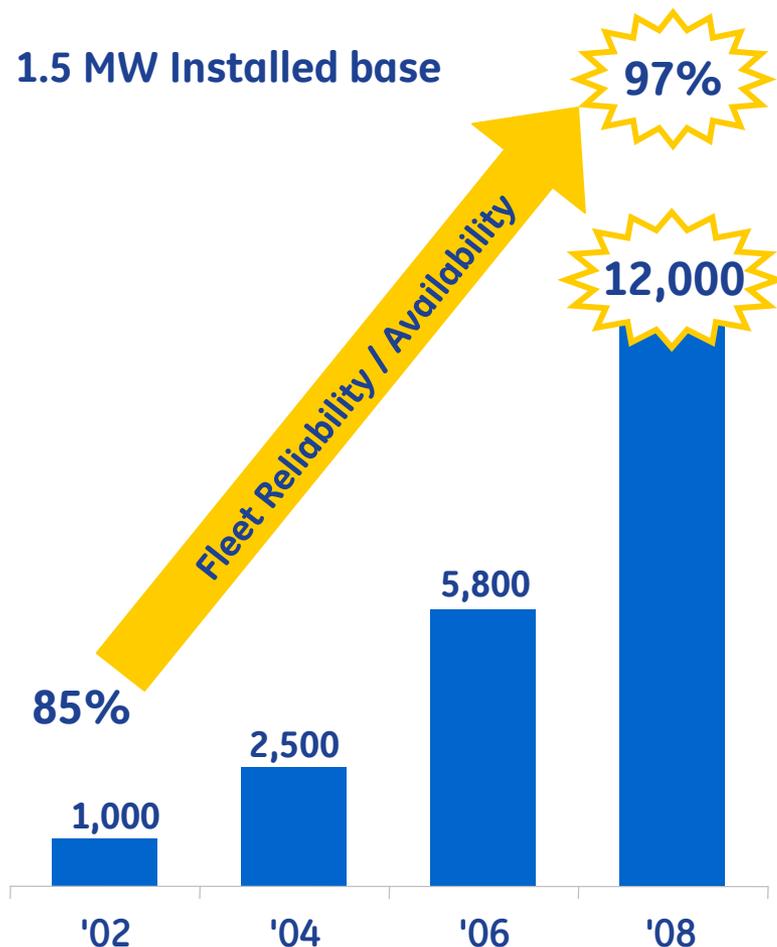
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Shu Ching Quek (PL)



imagination at work

Evolution of the 1.5MW

1.5 MW Installed base

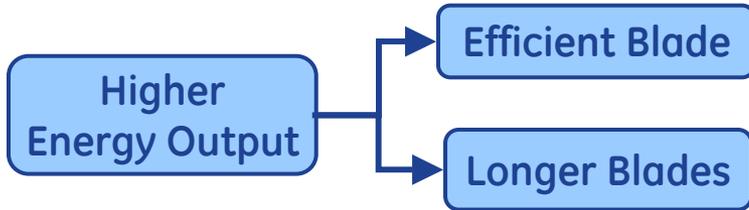


GE 1.5 MW	'02	'08
Rotor Size (m)	70	82.5
Cap. Factor (%)	39	48
Reliability (%)	85	97

Services leadership ... industries largest single unit installed base

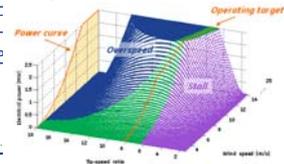
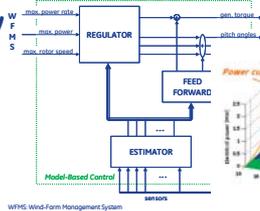
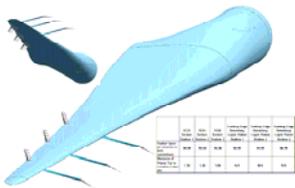
Technology - Blades

Increase capacity factor



Key enablers :

- Aero efficiency
- Noise control
- Gen torque density

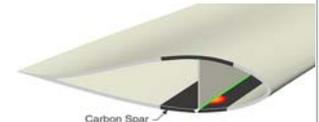


Loads Mitigation



Key enablers :

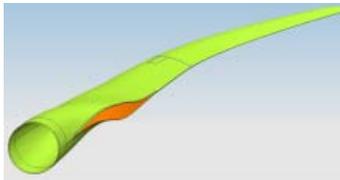
- Aero-elasticity
- Carbon composite spars
- Controls strategy



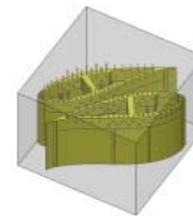
Blade Exploratory Concepts

Increase length of blade while controlling cost

- Load reduction enablers: Aero elasticity, carbon spar, MBC
- Constraints relievers : Aero/Noise tools validation, jointed blade



Modularity Concepts for Logistics



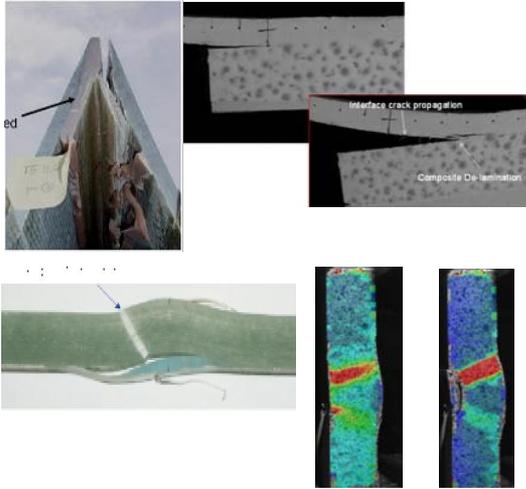
bolted



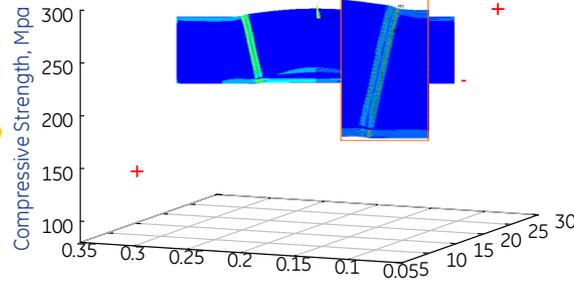
bonded

Validation key to technology growth

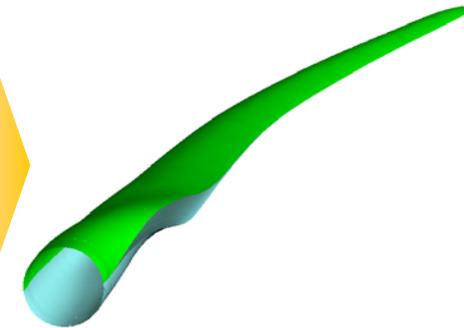
Design for Manufacturability



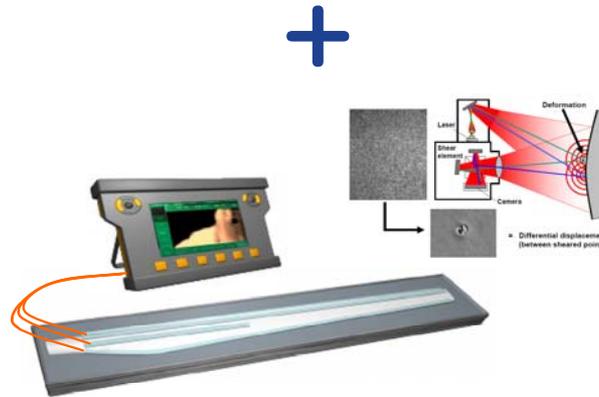
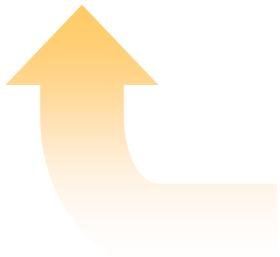
Manufacturing Limits



Micromodelling for design limits



Blade design & manufacturing



Non-destructive evaluation

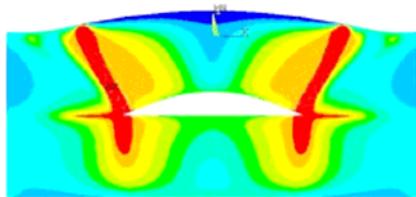


Longer Blade... Carbon Introduction

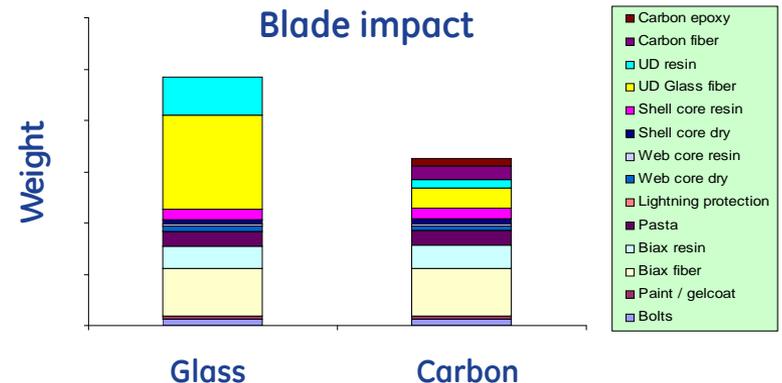
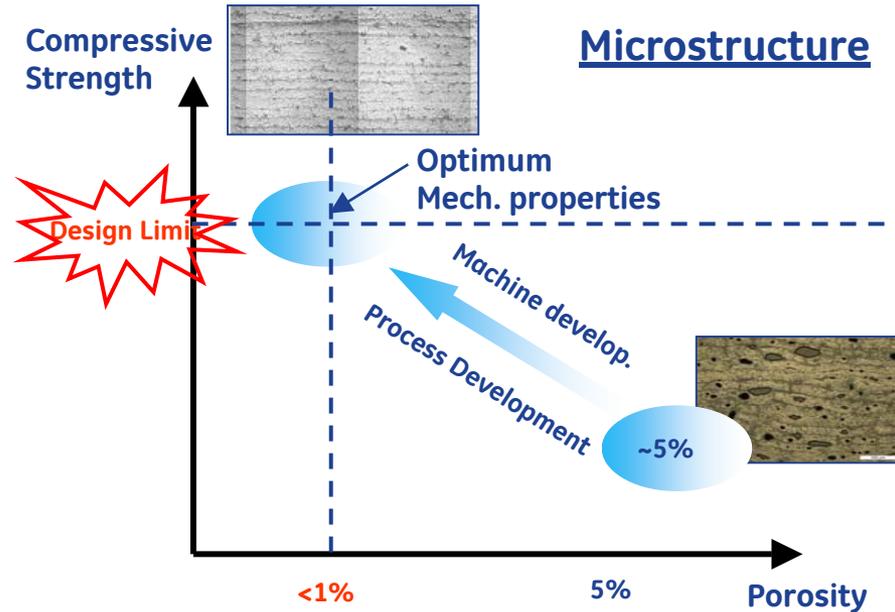
Artist Rendition of blade manufacturing



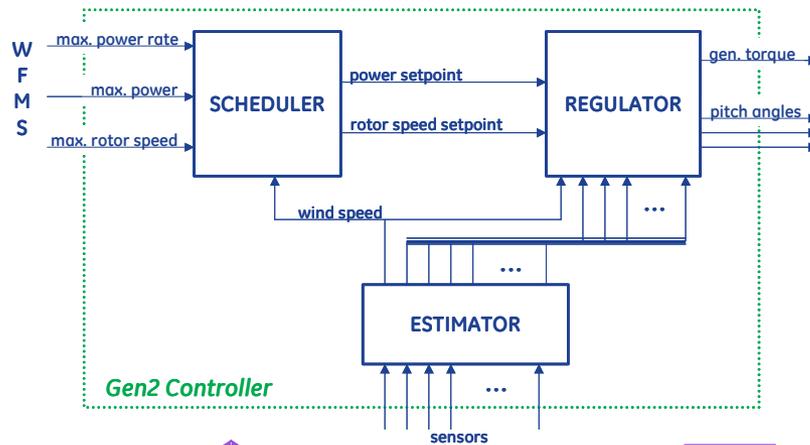
Advanced manufacturing development



Micromodel of fiber wave



Control Load Management



Component	% of turbine cost	AEP ^m		independent effects					
		↑10% blade length		Passive				Active	
		Fat.	Ext.	Carbon spar		Blade sweep		MBC	
		Fat.	Ext.	Fat.	Ext.	Fat.	Ext.	Fat.	Ext.
Tower		↑	↑	0%	↓	↓	↑	↓	↓
Gearbox		↓	↑	↑	↓	↓	↑	0%	0%
Blade		↑	↓	↓	↓	↑	↓	0%	↓

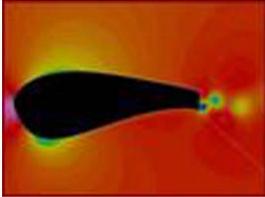


Need a combination approach for load management

Technology Drivers for Competitive COE

Blade Aero Modifications

Noise abatement



Power Performance

Winglets

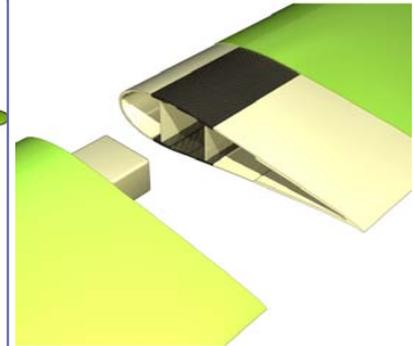


Aero-Elastic Sweep Geometry



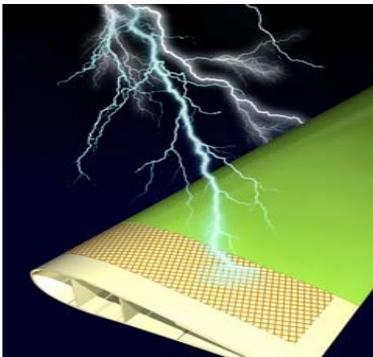
Reduces Aero load through bend twist coupling

Carbon composite and blade joint



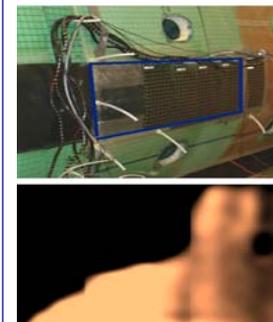
Carbon composite to reduce blade weight by 25-30%. Joint for logistical advantage

Faraday Cage



Enhanced lightning protection

Non-Destructive Testing



Real-time inspection technologies for manufacturing and assembly

Defect Physics



Design for reliability

Blade Automation

