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Company presentation We4Ce

Energy mission Japan,
October 27 – November 4, 2014

Composites Process Implementation Engineering

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- Mission & Vision
- History and Organization
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Mission & Vision

Vision:
To contribute to the reduction of climate change and to the access of sustainable energy for everybody.

Mission:
Strong integration of aerodynamic and structural design, materials, tooling and (production) processes

Make the many years of experience, knowledge and know-how on composites in a creative manner available for our customers to fulfil their needs

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History

Howden Fans

Aerpac (1989-2001) → Enron → GE Wind

CTC, NGUp, NOI, Suzlon Blade Techn. → SUZLON

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Organization

- Shareholders
  - Admin & Finance
    - Engineering
      - Aerodynamic design
      - Structural design
      - FEM
      - Loads
      - Materials
      - Testing
      - Certification
    - On-site Process and Production Support
      - Production support & proto typing
      - Supplier release & materials
      - Process testing and implementation
      - Shop auditing, Consultancy
      - Quality Management Systems
      - Product, Process & Cost Optimization
      - Supply chain development
      - Interim management
  - Marketing & Sales

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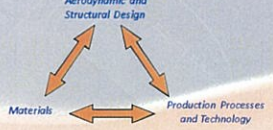
Approach Turn Key Solutions

We4Ce aims for turn key solutions for our customers by integrating all applicable activities in one team; from Aerodynamic & Structural design up to the implementation of the Products & Processes in a series production environment. Aim is to achieve the lowest product cost price.



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Engineering Skills & Tools

- Aerodynamic Design: Code BOT / ATG
- Structural design: Focus structural analyses, and Pro-E for 3D modeling and laminate drawings
- FEM: Ansys for IFF, test strains, platforms, nacelle covers, blade root
- Loads: Phatas/Bladed for blade load calculations
- Materials and specs: In house manufacturing of coupons and testing at IMA/WMC resulting in general material specifications
- Matlab / Fortran: data processing and interpolations

- Co-operation:
  Profile development, FEM, Loads, Aero-elastic stability, noise...

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Off Shore vs. On Shore

Differences between On Shore and Off Shore from a Rotor Blade perspective:

	Off Shore	On Shore
Turbine costs as part of total Wind Park costs: *(cost of installation...)*	~35%	~60%
Wind speeds	higher	lower
Wind shear due to lower towers *(changes also AOA, asking for advanced pitch strategy)*	lower	higher
Turbulence *(lowering the fatigue loads)*	lower	higher
Reliability of Blades due to accessibility	higher	lower
No. of blades per rotor *(2-bladed rotors: increase rotor speed, reduced drive train costs)*	2-3	3

Other aspects:
Up-wind or downwind – tip tower clearance.
Off Shore airfoils – turbine design specific

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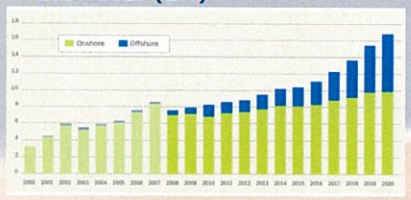
Wind energy annual installation 2000-2020 (GW)



Source: EWEA/GWEC

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Generic trend: Larger Rotor Blades

Typical design constraints, challenges and design criteria by designing larger rotor blades:

- Mass reduction needed: new materials with higher strength to weight ratio.
- Aero-elastic tailoring for enhanced damping/stability.
- Deal with variance on AOA of turbine.
- Erosion protection LE due to higher tip speeds.

.....Rotor Blade design for On Shore and Off Shore applications very similar.... 'only' using different settings and input variables.

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Track record designs

Rated Power/length	Wind Class	Rated Power/length	Wind Class
500/900kW		2.0 MW	
• 29.5 m.	III	• 43.5 m.	II
		• 46.5 m.	II
1.5 MW		• 50.3 m.	III
• 38.0 m.	II	• 51.5 m.	III
• 40.2 / 40.35 m.	II/III	• 54.0 m.	III
• 43.5 m.	III+	• 57.0 m.	III
2.5 MW		3.0 MW	
• 50.5 m.	II	• 50.5 m.	II
• 52.5 m.	II/III	• 56.7/61,2 m.	II/III
• 59.5 m.	III	• 59.5 m.	III
		6.0 MW	
Bushing concepts:	5.0MW (55.5m) 6.0MW (77.7m)	• 68.8 m	off shore

....plus customer specific/exclusive designs.....

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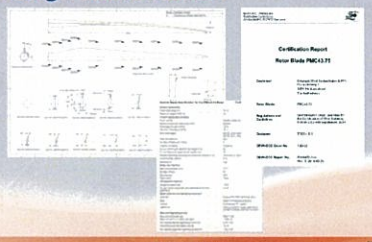
Design deliverables



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Design; Plug

Direct 2D and 3D format files from aerodynamic design:

- Plug design and input file for 5-axis router
- Contour shape with defined offsets
- Laser cutting files
- Flanges and process related options

Properties and features:

- Tolerances
- Mechanical & thermal properties
- Transport, storage and handling
- Chemical pre treatments
- Life cycle

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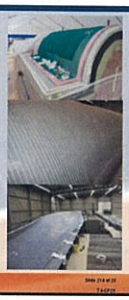
Design; Mould

Properties mould....Fit for purpose...!

Design features:

- Smart heating system
- Hydraulic hinge system
- Alignment & positioning system
- Integrated vacuum system
- Fine adjustment
- Prefabricated components
- Positioning jigs and fixtures
- Storage solutions
- Working platform
- Auxiliary tooling
- Internal transport and handling
- Health and safety issues



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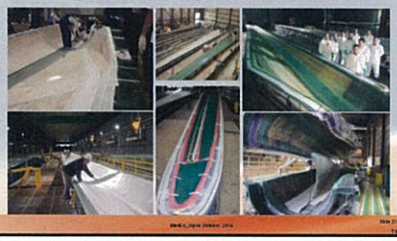
Production Start Up

Production start-up; various products & materials, global scale.



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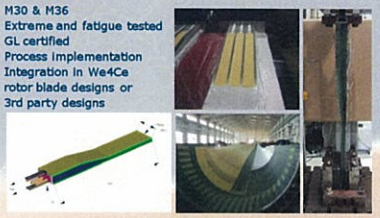
R&D activities; Bushing/insert

- M30 & M36
- Extreme and fatigue tested
- GL certified
- Process implementation
- Integration in We4Ce rotor blade designs or 3rd party designs



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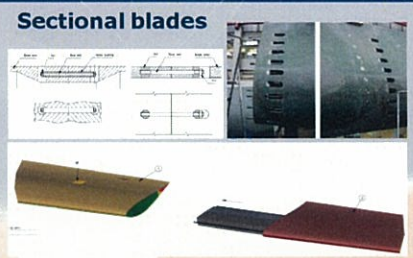
Sectional blades



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Sectional blades

- Onshore: up to 3.0MW.... ~60m Blade length
- No / limited steel parts
- Limited weight increase
- On-site assembly
- No maintenance; no tensioning of bolts
- No impact on aerodynamics
- No disconnect-ability...

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Lightning Protection

- Exchangeable Lightning spot; access
- Integrated Hoisting point
- Patent pending

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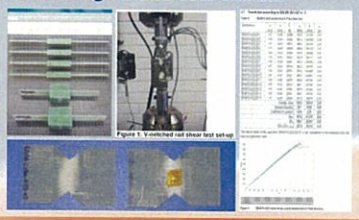
R&D activities

Material testing RT and Cold Climate



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Inspections

Factory inspections:

- Manufacturing monitoring & Quality Control
- Non Conformities & Repair Instructions
- Final Acceptance inspections (ex Works)

Wind Farm inspections

- Damages
- Root Cause Analysis
- Repair Instructions
- Final Acceptance inspections (prior to installation)

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Factory Lay-Out

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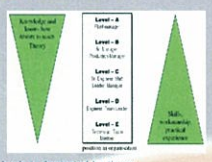
Technology Transfer

Technology Transfer approach:

- Train the Trainer – principle
- Manufacturing Flow of a Rotor Blade Production
- Trainings modules:
  - Theoretical part
  - Practical (laboratory scale and 'on the job')
- Quality



The emphasis by the (higher) management levels is dominated by *theory, knowledge & know-how* and the *ability to teach* others. The emphasis with the blue coloured/ technicians is more on the *skills* and *workmanship* and the *practical experience*.

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Technology Transfer

Training methodology:

- Interactive approach
- Theoretical and practical course
- Contents adjusted to trainee level
- Laboratory scale exercises
- 'Training on the job' where possible
- Based and focussed on production flow of rotor blade manufacturing


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Future Cooperation....
Discussion & Questions.....
Hendrik Jan Zwanenburg
hjzwanenburg@we4ce.eu
Mobile: +31 624 603 760
Office: +31 546 452 722