AREVA Wind
Lessons-learnt alpha ventus



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AREVA

Summary

- alpha-ventus project time-line
- Offshore installation
- Service life-cycle management
- M5000 performance
- Nacelle swap 2010
- Key lessons-learnt

alpha ventus
Main milestones

2009
March-July
Transport and mobilization

2009
April-May
Installation of tripods

2009
June-July
Erection of tower segments

2009
July-August
Nacelle and rotor installation

2009
August
Commissioning

2009/2010
October-March
Trial runs

2010
27 April
Official inauguration

Offshore Installation

- **Complete EPC scope of delivery**
- **Customized installation concept**
  - **GL-O Certified own developed lifting and transportation equipment**
  - **Vessel and crane solution for optimum operational conditions**
- **Efficient installation**
  - **1 turbine in a row**
  - **S3 lower tower section**
  - **S2 middle tower section**
  - **S1 top tower section**
  - **Nacelle**
  - **Hub as complete rotor star**
- **Optimized commissioning**
  - **Pre-commissioning**
    - Cabling work in tower sections and nacelle
  - **Cold commissioning**
    - Cable connection
    - Preparation of hot commissioning
  - **Hot commissioning**
    - I/O-Check
    - Test run

Fast and safe installation process

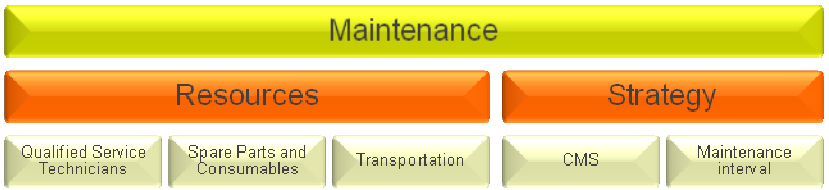
Service Life-Cycle Management

- 20 years design life-time
- More than 3500 different components
- Warranty of supply of spare parts during the 20 year operating time
- Very short response time for the most important spare parts during the contract runtime
- Dynamic stock management based on MTTF for each component – calculated on a yearly base
  - Onshore/offshore storage
  - Supplier agreements with guaranteed delivery times
  - In-house production

Reduced cost, improved availability and reduced risk of excess age of spare parts

Service Life-Cycle Management (2/3)
Full Service Scope

- **Inspection / Preventive maintenance**
  - TCM – Turbine Condition Monitoring, monitoring of oscillation level
  - Use of automatic lubrication system (bearings und yaw gears..)
  - Inspection of turbine at each visit
- **Corrective Maintenance**
  - Regular maintenance on the basis of detailed checklists
  - Gearbox oil- / and hydraulic oil exchange
  - Check of safety installations
- **Repair / Unscheduled Services**
  - Repair and fault clearance also weekend and holidays
  - Fast reaction on stopped turbines
- **Optimization**
  - Perform modifications and updates



Activities of maintenance based on: DIN 31051

How many faults can be handled online without visiting the turbine? ***86%!***

Service Life-Cycle Management (3/3)
Transport solutions

- **The optimal and cost-efficient model for the strategic operation of the wind farm, depends on:**
  - Number of turbines in the wind farm
  - Distance of the wind farm to the coast
  - Structure of the wind farm (equipment substation etc.)
- **AREVA Wind's transport solutions**
  - Model 1 – onshore supply
  - Model 2 - substation light equipped
  - Model 3 - substation fully equipped
- **The alpha-ventus transport solution**
  - Model 1 – onshore supply
  - Helicopter: Flexible, fast, more time to finish the job (<12h)
  - Ship: Enough load capacity for big jobs, longer stay in the wind farm

Accessibility to alpha ventus is ensured over 90% of the time by helicopter and 60% of the time by ship

alpha-ventus M5000 performance

- The six AREVA M5000 turbines have already generated close to 90 GWh out of total 120 GWh feed into the grid from the alpha ventus offshore windpark since October 2009
- 2 turbines stopped from April/ May to September 2010. Other turbines have demonstrated a technical availability of more than 97%
- The special offshore turbine design including condition monitoring, failure detection and system redundancies for enhanced reliability means that 86% of have been handled online without visiting the turbine

alpha ventus
2010 nacelle swap

2009
March-July
Transport and mobilization

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April-May
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June-July
Erection of tower segments

2009
July-August
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2010
August-Sept
Nacelle swap and full re-commissioning

alpha ventus nacelle swap (2)
Guaranteeing strong future performance

- Two turbines were stopped due to failure detection from the condition monitoring system caused by higher temperature of one of the slide bearings
- Root cause analysis has been successfully performed. New slide bearing materials were identified as the only cause
- The design and construction of the M5000 is validated through the root cause analysis and design review
- The slide bearing design has been rolled back to the original proven configuration
- The nacelles on the two turbines have already been exchanged and the re-commissioning has been completed
- The remaining four turbines have been fully operational and will be exchanged in the next 2 to 5 weeks as a preventive measure to guarantee continued strong performance

The M5000 nacelle can be swapped in as few as 12 hours depending on weather conditions ensuring minimum down-time

Key lessons-learnt & solutions for future projects (1/3)

- **Accessibility of turbines (days):**
  - **Reasons for non-accessibility via helicopter:**

• Fog (so far only visual flight / no instrument flight allowed)	• Icing on rotor blades of helicopter
5	1

- **Ratio between crew vessel and helicopter for fault clearance:**

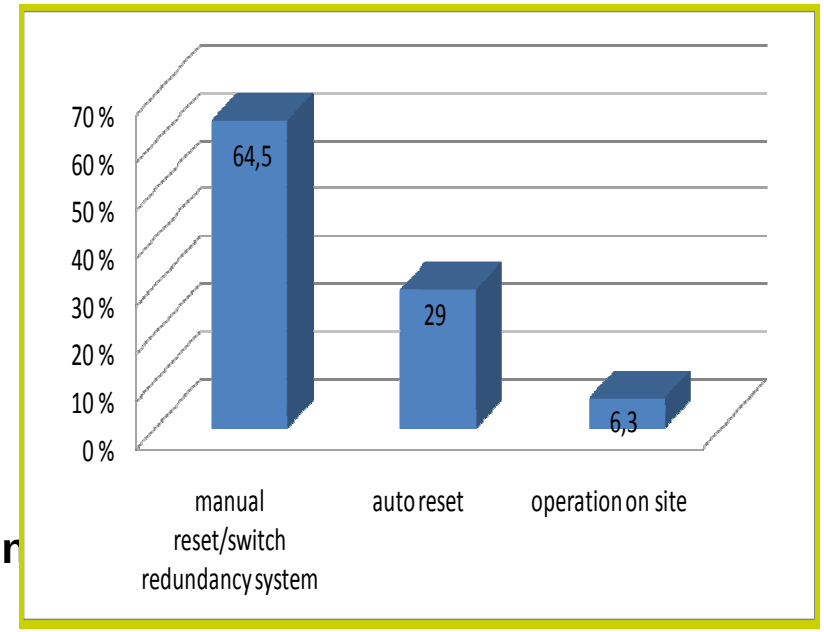
• Vessel	• helicopter
31 %	69%

- **Ratio between crew vessel and helicopter for scheduled repair:**

• Vessel	• helicopter
56 %	44%

Key lessons-learnt & solutions for future projects (2/3)

- **High availability in the first weeks of operation after commissioning period – no bathtub curve, reasons:**
  - **Pre-commissioning of nacelle and S3 incl. converter, transformer, cooling system**
  - **Pre-commissioning of hub at the end of manufacturing process**
  - **Only 1 Service job performed at one turbine in the first two months of operation**
  - **All other errors occurred could be handled via online SCADA System due to redundancy system**

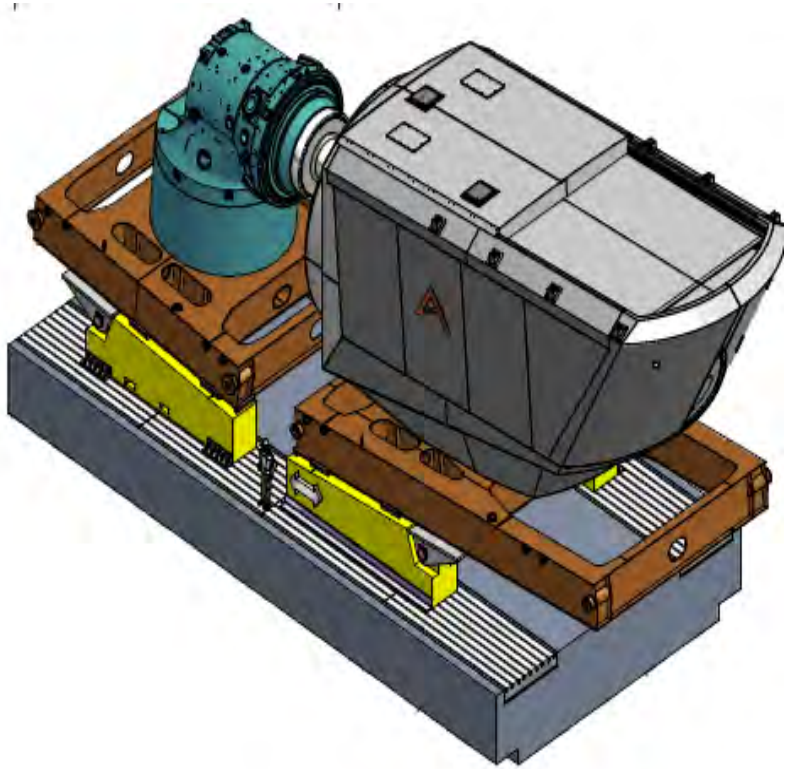


Evaluation time 16.03.2010 until 16.06.2010

How many faults can be handled online without visiting the turbine? 86 %

Key lessons-learnt & solutions for future projects (3/3)

- Invaluable EPC experience on 1st deep-water pilot project in German North Sea
- Validation of technical risk assessment for industrial ramp-up for procurement, manufacturing and construction, including:
  - Investment in a Test Facility for full 5MW load test of all assembled nacelles in Bremerhaven
- Time to scale up organization until large projects in 2012+
- Business model will be adjusted to address wind offshore industry requirements:
  - Commitment to secure heavy-lift vessel solutions for offshore logistics
  - Long-term maintenance services proposed to improve wind farm performance



Thank you for your attention!