

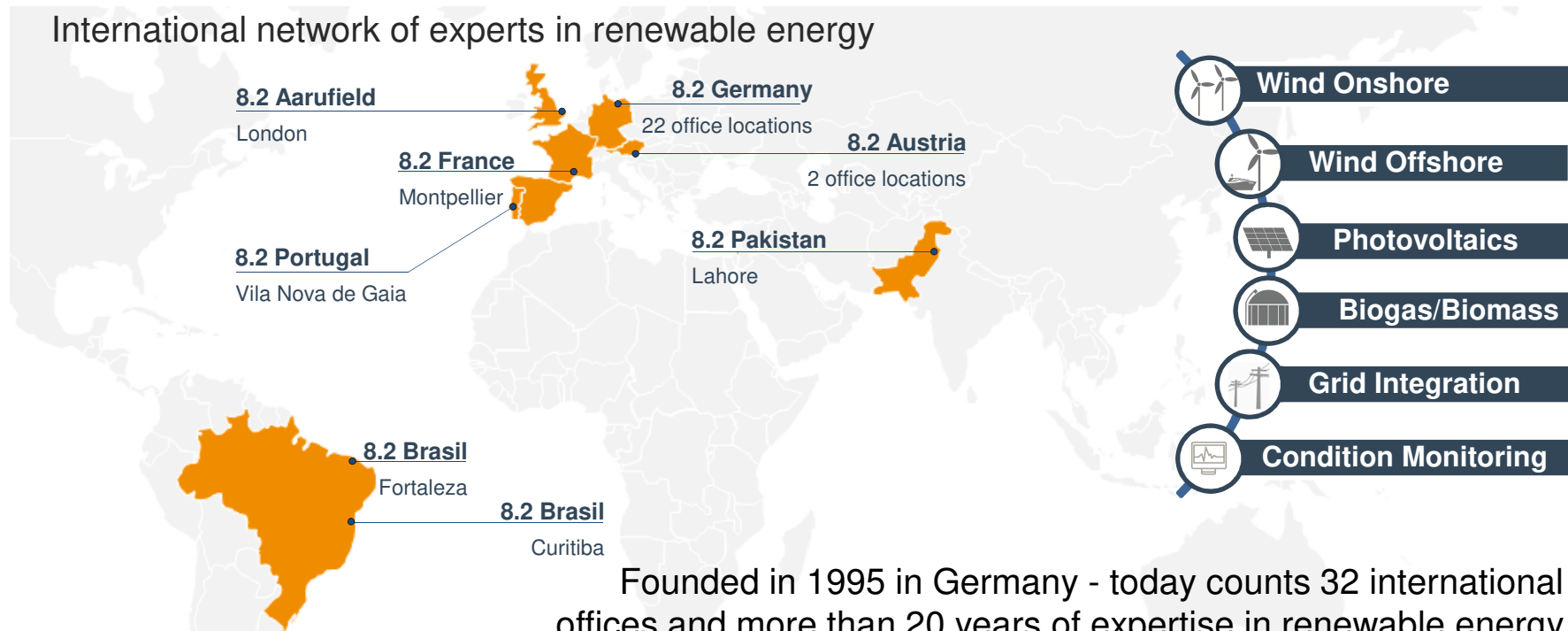
Quality Assurance Offshore

View from an Independent Inspection Body

From manufacturing surveillance to periodic inspection campaigns offshore







8.2 Group

International network of experts in renewable energy



Founded in 1995 in Germany - today counts 32 international offices and more than 20 years of expertise in renewable energy

8.2 Group Expertise – a selection

	In-depth knowledge of all turbine types > 40 000 turbines inspected
Due diligence of more than 15 GW onshore/offshore worldwide	
	More than 4 GWp PV projects
More than 20 years of experience in the area of CHP technology with biomass/biogas	
	Risk based design review performed for various turbine types (on-/ offshore)
Lifetime extension of turbines > 1 000 expert opinion prepared	

Advisory services

- Package management
- Technical due diligence
- RCA and value analyses
- Grid connection expertise
- Operation optimization

Technical assessments

- Asset inspections along full life cycle
- Lifetime extension assessments
- Audits & production surveillance
- Commissioning supervision
- Condition monitoring (online/offline)

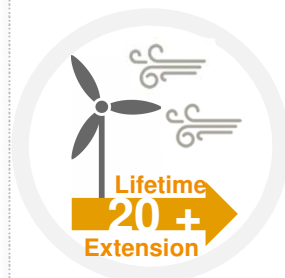
Areas of Expertise



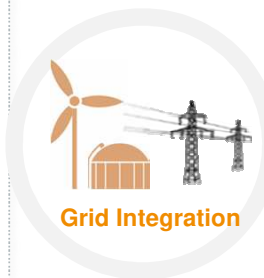
- Factory audits and supplier assessments
- Production surveillance of major lots
- Assessment of quality control plans



- Independent technical inspections
- Inspection after commissioning, end of warranty, periodic and condition based inspections



- Lifetime assessment
- Determination of the remaining life time
- Trend analysis
- Expert opinions for on- and offshore WTG



- Consulting on grid integration
- System certification
- Conformity assessments
- Expert opinions
- Simulations and analyses

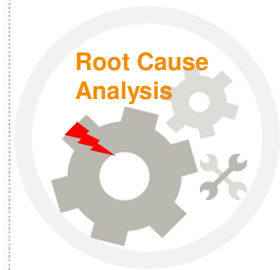
Areas of Expertise



- Detailed techno-economic assessment of all relevant asset properties
- Recording of all technical risks
- Reduction of the economic risk of the investment



- Technical consulting along the entire project life cycle
- Strategic consulting
- Contract support
- Practice-based consulting



- Damage- and root cause analysis
- Publicly appointed and sworn experts
- Recommendations for damage prevention



- Consulting and support along the entire project life cycle
- Creation and implementation of HSE-project concepts and project documentation

Offshore Wind



- Due diligence of more than 5 GW offshore
- Manufacturing surveillance in over 17 OWP
- Contract advisory and package management for various project owners
- Preparation of employer requirements for WTG & OSS packages and grid code compliance for various project owners
- Extensive know how of offshore WTG
 - Design
 - Manufacturing and operation

Offshore Wind – WTG knowledge



- Siemens Gamesa G4 | D8 platform
- MHI Vestas V112-3.x | V164-8.x
- Senvion 5M126 | 6M126 | 6.2M152
- GE Haliade 150-6MW
- Adwen AD 5-116 | AD 5-135 | AD 8-180
- BARD 5.0



8.2 Product Portfolio Offshore Wind

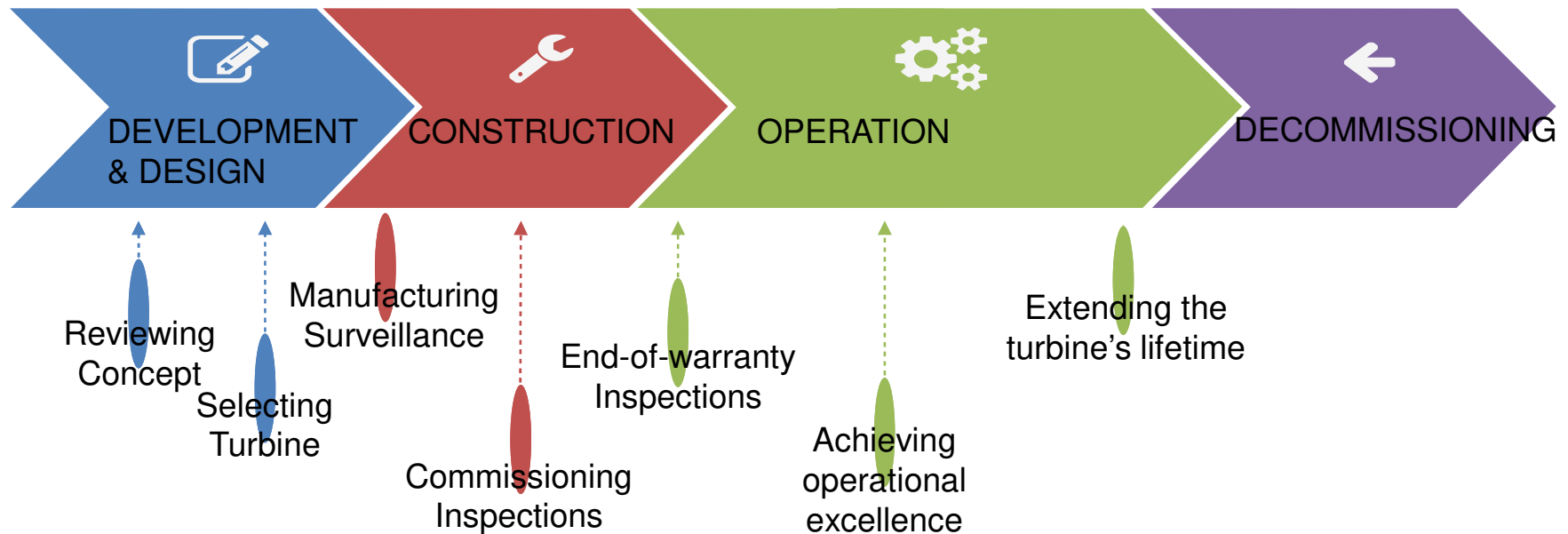
	Project definition	Project design	Construction & Commissioning	Operation & Maintenance
Project review and support	Technical Due Diligence Owner's engineer Lender's engineer Advice on grid connection Strategic advisory			
	Feasibility studies Consulting (eg. contracts) Technical evaluation of cost benefit analysis	Design Review Assessment of specifications Survey on deconstruction costs	Compilation & assessment of quality control plans Conformity scope of delivery, purchase contract	Consulting with regard to O&M
Quality assurance & control		Audit production site	Manufacturing control for WTG (machinery / blades), substation Construction supervision Supervision of commissioning	
Inspection			Inspection after commissioning	Periodic / condition based inspection Inspection of substation EoW inspection Root cause analysis
Special tasks	Second Opinion ESCROW Project management Moderation / facilitation of workshops or similar			

Expertise in QA (a selection)

- > 500 WTG during manufacturing
- > 200 WTG at commissioning
- > 500 WTG inspections along operation
- We know how manufacturers are working
 - Experience based on previous projects. We know the internal procedures and specifications.
 - Production sites and processes are well known.
- Creation of employer requirements
- Contract negotiation support



Project Lifetime



Important milestones

- Contract signing
 - Taking over
 - End of Warranty
 - End of service contract
-
- QA only important during manufacturing?

QA: Is it necessary?

- WTG supplier
 - You are buying a serial product!
 - more than 100 WTG manufactured ?
 - new production facilities?
 - Don't disturb our production process!
- OSS supplier
 - Everything will be fixed later.....
 - For every small repair offshore certified technicians are needed!
 - Commissioning as much as possible onshore

QA planning: Basics

- QA starts at Employer requirements
 - required documentation
 - securing access rights
 - Preparation phase
 - how to evaluate the inspection results?
 - how to act?
 - Inspection phase
 - common understanding of all parties involved
 - Lessons learned
 - improvement for next projects
-

QA planning: Basics part 2

- WTG supplier
- Supplier: bearing
- Sub-supplier: rolling element

- Where to perform QA?
 - Will I see my products? -> Forward traceability

- Incoming goods inspection
 - properly done?

QA planning: Basics part 3

- Like IoT or Industry 4.0
 - you have to handle and understand the amount of data
- No word files
- Electronic searchable
- Central LOP or similar
 - Content to be shared and discussed

Risk based inspection schedule: WTG

- Design review of contracted WTG
 - Criticality of component
 - Complexity of component
- Supplier evaluation
 - Experience with component
- Aligned supervision concept (ITP)
 - Process audit
 - FAT/FAI
 - Inspections

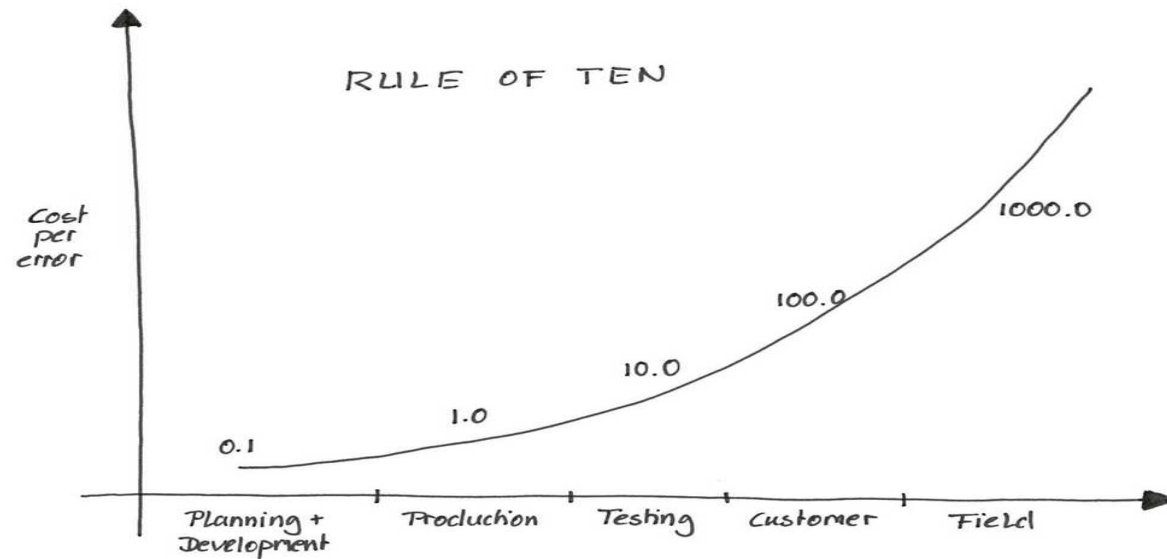
Inspection and Test plan (ITP)

- Most important document for manufacturing surveillance
 - What will be checked
 - What is the scope
 - Checklists to be used
 - Who participates
- Beware of hold points

Ideal inspection regime

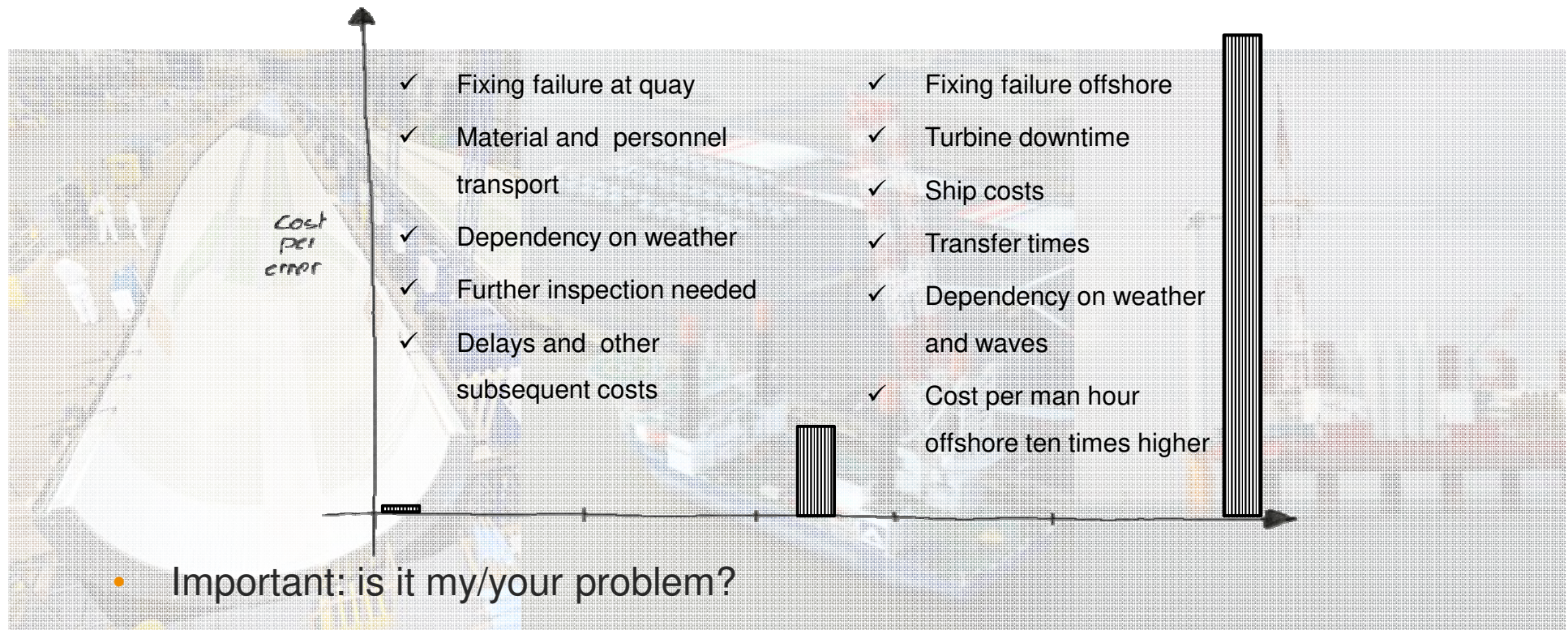
- Full scope inspections at start
 - find the weak spots and where to look for
 - Reduced scope afterwards
 - Ideally unannounced spot checks
 - difficult to negotiate
 - Selected sub-suppliers
 - WTG supplier
 - Pre-Assembly (including storage!)
 - Commissioning
-

Cost of quality – “Rule of Ten”



- “Detecting and fixing a problem during production is 10 times faster and cheaper than doing so in the next phase”

The Offshore – “Rule of Ten”



Non-critical vs. critical issues

- Damages of corrosion protection
 - there will be more during installation ☹️
 - fix during concentrated campaign
- Wrong storage conditions
- Repairs under non-controlled environmental conditions

Major findings

- Quality greatly improving with number of WTG produced
 - per location!
- Deficiencies with incoming goods inspection
- Non-conformance with storage specifications

Contract prerequisites

- No secured inspection rights in contract
 - No proper inspection possible
- Documents to be delivered
 - Long discussions afterwards
 - Certain documents can't be created at a later stage (test reports)
- Aligned information policy
 - Production at different facilities

Storage example



- Spec: max 5 over each other
- Damage will occur after 1 or 2 years of operation

Quality example: Corrosion



- Not detected at incoming goods inspection
 - Can not be detected after assembled and will result in failures
-

Production example



- Missing earthing due to corrosion protection
 - Fixed offshore by mechanical grinding of surface
-

Design issues – not to be detected

» Areva bearing alloying

- Problem
 - Temperature spikes in the turbine due to bearing alloying
- Root cause
 - Local supplier switched bearing alloying from zinc to a zinc alloy
 - Twice as much thermal expansion
- Action
 - Replacement of bearing
 - Requires complete exchange of nacelle

Periodic inspections

- Special requirement in Germany from the BSH
 - All WTG within a 4 year period
 - Only covering structural integrity and operational safety
- Interest from operator has to be higher
 - 3rd party inspection to check quality of service company
 - 3rd party evaluation of overall WTG condition and performance
- Can be combined with other inspections (i.e. End of Warranty)

Offshore inspections

- In general same scope as offshore
 - Inspection of machine
 - Rotor blades by rope access or other means
 - Boroscopic inspections of bearings and gearbox
 - Vibration analysis
- Additional topics
 - Helicopter hoist, navigation lights
 - Under water inspections of foundations
 - OSS equipment (electrical and auxiliary systems)

Challenges

- Logistics and access
 - Very different to onshore wind
 - Coordination with service personnel and CTV
- Weather
 - Wind
 - Waves
- -> Inspected WTG per day lower than onshore
- Greatly improved by Walk-To-Work vessels

Challenges

- Some inspections require special skills
 - Under water inspection of welds
- Every person has to be offshore qualified
 - Inspection of waste water system on OSS
- Planning of concentrated campaigns
 - Limit stand-still times
 - Preferable during summer times (better weather and less lost revenues)

Major findings during operations

- In general comparable with onshore WTG
 - More wear due to higher utilization and loads
 - More corrosion due to atmosphere
- Settling of power cables onto sharp edges
 - Risk of short circuits
- Leakage of hydraulic systems
- Great differences even for the same WTG type
 - Contract different?

Major findings during operations



- Damages of leading edge after very short operation time
 - Extensive repair campaigns necessary
 - Who has to pay for it?

Do you know enough?



- This is not a picture from the installation phase!
 - Design failure: weld geometry, distance from flange
 - Problem known at Bonus: retrofit available, not implemented
-

Where to look for?

- Inspection schedule based on existing knowledge
- Documentation is backbone of everything
 - Digital life cycle record
 - In which turbines component XY is installed?
 - Don't rely on turbine OEM
- Basis for O&M
- Evaluation of data from Condition Monitoring System (CMS)

Inspections as part of asset integrity

- “Asset integrity lies at the heart of achieving long term reliability, predictable costs, and reduction of the cost of electricity“
- Learn from the field, take what you have learned and go upstream in the next project
- Focus on the machine that earns your living
 - Make sure it gets installed and commissioned right
 - Characterize and monitor
 - Intelligently plan interventions
 - Plan for swapping out equipment and rotating spares

8.2 | The Experts in Renewable Energy

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