



EUROPEAN TECHNOLOGY & INNOVATION  
PLATFORM ON WIND ENERGY

# Operation & Maintenance

# Scope of the discussion

- Considered R&I areas must
  - benefit from a collaborative approach including industry and academia
  - fit for a funding period **starting in 2018**.
- Timeframes:
  - Short term = results expected by 2020-2025
  - Mid term = results expected between 2025-2030
  - Long term = results beyond 2030

# O&M - Defining the timelines

Priority	Delivery by 2020-2025	Delivery by 2025-2030	Delivery post 2030
Standardized and validated methods and sensor systems for performance measurement and condition monitoring	X	X	
Improvements in energy yield from wind farms through utilization of adaptive, and interactive and big data control	X	X	
Improvements in reliability and predictability of wind farms and data analysis to improve diagnostics and decision-making	X	X	
Lifetime optimization	X	X	
Others?			

## Standardized and validated methods and sensor systems for performance measurement and condition monitoring

By  
when

Sensors improvement: Reliability, redundancy, sensor protection, maintainability (Low or zero maintenance, self-diagnostic systems), remote sensing, wireless communications, recording systems.

New/enhanced sensors for: Grouted connections, joint failures, electrical systems, fatigue, crack initiation, scour development, cyclic degradation, marine growth, SHM in submerged areas,...

New and enhanced measurement systems for external conditions integrated with WT control system, CMS, RMS,... i.e. inflow sensors, metocean conditions

Development of standards for power curves assessment based on new measurement technologies (i.e. nacelle lidar).

Standardization and development of new capabilities for CMS/RMS/SHM.

Use of remote inspection and data analysis systems (ROVS/Drones/CMS vs Divers). Analysis of the use of CMS vs ROVs/Maintenance + underwater remote inspection and condition monitoring (new)

Acquisition, modelling, sharing tools and documentation of basic material data and standardisation of performance testing / certification methods for materials

Repair methods

Improvements in energy yield from wind farms through utilization of adaptive, and interactive and big data control	By when
<p>Integration of CMS, RMS, SHM, scada info, metocean info, into a big data analysis tool (expert system).</p> <p>Development of maintenance strategies reducing turbine downtime and interaction with turbine control system for yield maximisation.</p> <p>Correlation of cumulative fatigue life damage with metocean data and operational data.</p> <p>Efficient collection of data and improved data analysis techniques.</p>	
<p>Acquisition, modelling and sharing of monitoring and O&amp;M data</p> <p>Improve yield and reliability at wind turbine, wind farm and cluster levels</p> <p>Use of O&amp;M data for feedback wind turbine design</p> <p>Improved yield availability based on optimisation of energy prices</p>	

## Improvements in reliability and predictability of wind farms and data analysis to improve diagnostics and decision-making (1)

By  
when

Wakes and inflow modelling

Modelling for crack initiation and growth prediction. Failure identification through investigation of faults and effects, through i.e. built in sensors.

Online diagnostics and prediction of structural health and component reliability, based on inflow, power/load measurement, metocean conditions,...

Development of condition and risk-based maintenance and O&M strategies (including feedback from field service experience).

Integrated design and design of foundations considering construction, installation, O&M and lifetime.

Assessment of structural design based on advance modelling and operational actual loads/conditions against design loads.

CAPEX (design) vs OPEX (maintenance) decision making.

Concepts with fewer components. Simplification of systems.

Easy replacement of components for remote/difficult to access or reduced weather windows sites. Access technologies (i.e. vessels/transfer systems).

Better weather forecasting tools and planning and logistic tools (offshore)

# O&M - Defining the timelines

Improvements in reliability and predictability of wind farms and data analysis to improve diagnostics and decision-making (2)	By when
Industry standards for decision making on O&M interventions	

# O&M - Defining the timelines

Lifetime optimization (1)	By when
<p>Fatigue analysis: Improve understanding/measurement of fatigue, remaining life and failure mechanisms.</p> <p>Better understanding of leading edge blade erosion + standardisation, testing</p> <p>Lifetime optimisation</p> <p>Development of life extension projects. Analysis of service life vs design life.</p> <p>Development of end of life strategies: repowering and decommissioning including offshore</p> <p>Offshore: Further knowledge on soil-structure-turbine</p>	



**Improvements in reliability and predictability of wind farms and data analysis to improve diagnostics and decision-making (1)**

**2020 2025  
2025 2030  
post 2030**

Transport and handling equipment condition monitoring ?

WTG Cybersecurity

H&S research (need to be better defined)

Cold climates

High altitudes ? (long term)