

Automated Inspection & Repair of Turbine Blades

Towards Zero downtime and Zero on-site maintenance

End event 24th Nov 2022



Part of the Airtub project

Data processing and Business Case







Data processing

AIRTuB WP 4



- Acquisition
- Cleaning
- Enrichment
- Data storage

Data Sources:

- Historical Performance data
 - Operations
 - Maintenance
- New sensor Data
 - Laserscanner
 - Ultrasonic sensor



							Data	Energy	
		Blade angle (pitch	Capacity				Availabili	Export	Energy Theoretic
turbineld	DateTime	position) (Å')	Factor (%)	Current L17U (A)	Current L27V (A)	Current L37 V (A)	y(%)	(k.₩h)	(k₩h)
NL.OFF.F	1-1-2017 00:00	-0.5	0.9085	15.199.000.244.140.600	15.364.000.244.140.600	15.374.000.244.140.600	1.0	304.0	280.733.325.004
NL.OFF.F	1-1-2017 00:10	0.699999988079071	0.970599975	1623.0	1.639.800.048.828.120	1641.5	1.0	328.0	298.833.328.564
NL.OFF.F	1-1-2017 00:20	4.400.000.095.367.430	1.0	1.689.699.951.171.870	1.706.199.951.171.870	1.709.199.951.171.870	1.0	328.0	320.733.331.362
NL.OFF.F	1-1-2017 00:30	2.799.999.952.316.280	0.999099975	1694.0	1.710.699.951.171.870	1.714.199.951.171.870	1.0	336.0	316.199.990.59
NL.OFF.F	1-1-2017 00:40	1.399.999.976.158.140	0.9901500244	1.673.300.048.828.120	1690.0	1.693.800.048.828.120	1.0	328.0	308.800.009.405
NL.OFF.F	1-1-2017 00:50	1.399.999.976.158.140	0.986549987	16.675.999.755.859.300	16.840.999.755.859.300	16.879.000.244.140.600	1.0	328.0	306.333.333.333
NL.OFF.F	1-1-2017 01:00	0.10000000149011612	0.956799987	16.179.000.244.140.600	1.634.199.951.171.870	16.370.999.755.859.300	1.0	320.0	301.333.338.10
NL.OFF.F	1-1-2017 01:10	12.999.999.523.162.800	0.9902000122	1.673.300.048.828.120	16.895.999.755.859.300	1692.5	1.0	328.0	306.333.333.333
NL.OFF.F	1-1-2017 01:20	3.299.999.952.316.280	0.999400024	1687.5	1.703.800.048.828.120	1.706.800.048.828.120	1.0	336.0	318.666.666.666
NL.OFF.F	1-1-2017 01:30	20.999.999.046.325.600	0.9818499755	1.659.300.048.828.120	1.675.300.048.828.120	16.779.000.244.140.600	1.0	328.0	308.800.009.409
NL.OFF.F	1-1-2017 01:40	2.0	0.987799987	1.669.699.951.171.870	1.686.199.951.171.870	1.688.699.951.171.870	1.0	328.0	306.333.333.333
NL.OFF.F	1-1-2017 01:50	0.0	0.942400024	1.593.300.048.828.120	16.094.000.244.140.600	16.114.000.244.140.600	1.0	312.0	293.833.333.333
NL.OFF.F	1-1-2017 02:00	12.999.999.523.162.800	0.98625	16.675.999.755.859.300	16.839.000.244.140.600	16.865.999.755.859.300	1.0	336.0	306.333.333.333
NI OCCI	11 2017 02:10	19 000 000 F99 109 000	0 070580007	10 514 000 244 140 000	10 074 000 244 140 000	10 700 999 7EE 0E9 200	10	220.0	one 000 000 000

Field



New Asset management strategies

AIRTuB WP 7





		Inspection	Repair
Big Drone	Scenario 1a	4-K Camera + Laserscanner+ Crawler ultrasonic	Rope access (seperate)
Big Drone	Scenario 1b	4-K Camera + Laserscanner+ Crawler ultrasonic	Crawler during inspection (cat 1 and 2)
HUB	Scenario 2	Autonome inspection with 4-K Camera + Laserscanner+ Crawler ultrasonic	Crawler (cat 1 and 2)
Small Drone	Scenario 3	inspection with 4-K Camera + Laserscanner+ Crawler ultrasonic	Crawler (cat 1 and 2)

New scenario's in business case Inspections: Groups of variables to look at









General	
# WTB	
# Milj kWh WTB in a year	
(average), 3MW	milj kWh
€ per kwh	€
Yield per hr per WTB	€ / hr
# Bad weather days	# Days/yr
% of planned activities are	
Cost CTV vessel	€/day
Cost SVO vessel	€/day
Labor cost Operator	€/day
Labor cost Technician	€/day
Labor cost Drone Operator	€/day
Labor cost Bad weather	€/day
Data analytics & Reports	€/WTB

#/yr	
#/vr	
,	
hrs/M/TB	
#	
#	
#	
#/Day	
#/day	

Logistics	
Vessel 1 needed (one per team)	СТV
Vessel 2 needed	SVO
Impact & Cost	
Downtime (total)	
Total # actual Inspection days of all	
WTB's (rounded)	# days
Inspection Cost	Labor
	Materials
Labor cost bad weather days	€/Yr
Logistic Cost	
Data analytics	Labor
Lost of production	€ 🖕



TNO O&M Planner Inspections: Groups of variables to look at



SCENARIO: AIRTuB drone	Calculation	TNO O&M planner(PW) ¹	TNO O&M Planner(3yrs)
Duration (days)	6	6	9
Personnel costs inspection (k€)	27	27	33
Vessel costs (k€)	72	72	88
Total O&M costs (k€)	99	99	121
Harbour costs (k€)	-	10,30	10,37
Yield based availability (%)	-	-	99,97



Metocean hindcast weather data



New scenario's in business case

Maintenance Cost baseline 1 versus new scenario 1 and 3 :

• Less repair and inspection time (learning curve, better classification)

Future

- Less Logistic Cost
- Postpone end of life

Higher AEP

Early Warning of degradation/damages Better insight health blades thus better planning

Autonomous inspection and repair from HUB - (Repair by crawler, less logistic cost and big learning curve)

- 40-80 % Reduction of Maintenance cost possible



+ 1-3%



Vragen ?







A Fluor Company

