AIMWind

AIMWind – Analytics for asset Integrity Management of Windfarms

Funded by The Research Council of Norway

UNIVERSITETET I AGDER

NORCE

TU Delft

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Agenda

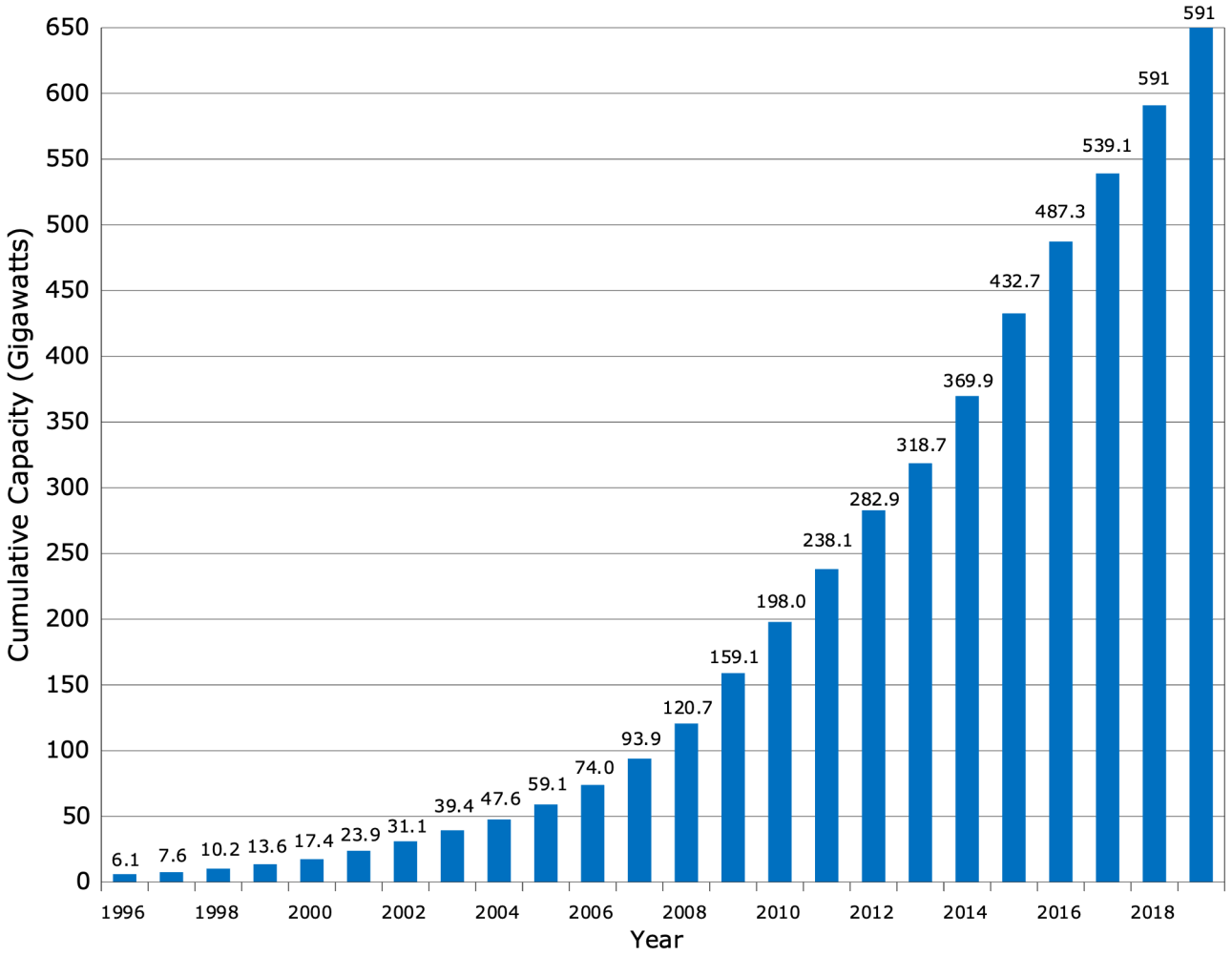
- Background & Motivation
- AIMWind Research Avenues
- Work scope
- Project & People

Wind Energy Facts

As many as 20,000 offshore WTs will reach end-of-life from 2030 – 2040[2]

About 65 GW of European onshore WTs will require upgrades or repowering by 2028[1]

If a WT operates for 30 years instead of 20 years, its carbon footprint can be reduced by up to 50%[3]



Global wind energy capacity

[1]W. Mackenzie, "65GW of European onshore wind turbines need upgrades or replacements by 2028." [Online]. Available: https://www.woodmac.com/press-releases/65GW-European-onshore-wind-turbines-need-upgrades-or-replacements-by-2028 .
[2]E. Topham, E. Gonzalez, D. McMillan, and E. João, "Challenges of decommissioning offshore wind farms: Overview of the European experience," J. Phys. Conf. Ser., vol. 1222, no. 1, 2019, doi: 10.1088/1742-6596/1222/1/012035.
[3]E. Lantz, M. Leventhal, and I. Baring-Gould, "Wind Power Project Repowering: Financial Feasibility, Decision Drivers, and Supply Chain Effects," doi: 10.2172/1117058.

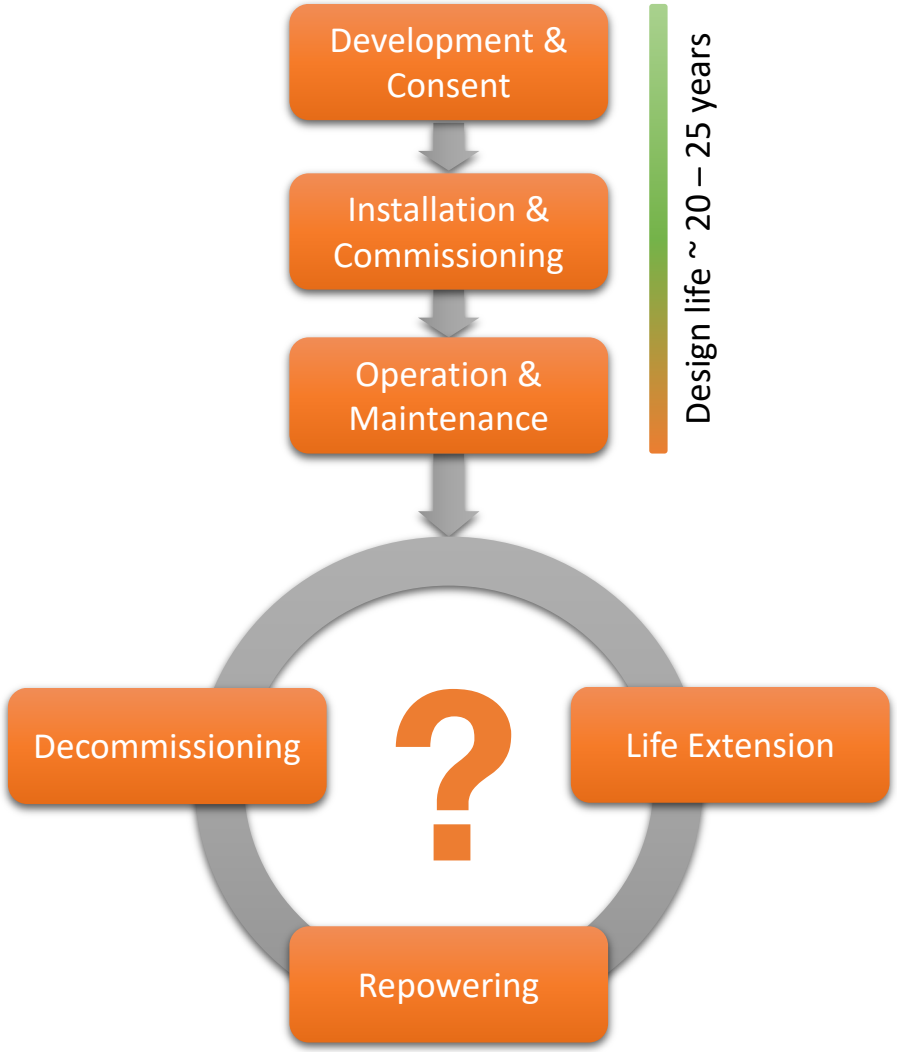
Life extension and repowering

- End-of-life scenarios:
  - *Life Extension* – Depending on remaining life of turbines, extend service life and production of the wind farm *as is*.
  - *Repowering or Up-powering* – Change *parts or entire* wind turbines to provide improved power output from the wind farms.
  - *Decommissioning* – removal and recycling of wind turbines.

- Which way is right for the wind farm?

No general answer. Site-specific, depends on:

- *Accumulated fatigue of structures* – operation, downtimes, wind and wave conditions…
- *Machinery life* – operation, reliability, maintenance history, cost of maintenance...
- …



Repowering to be a US$ 25Bn. industry by 2030
National Renewable Energy Laboratory (NREL) USA

Accurate assessment of remaining life → Low risk on guarantees for life extension & repowering

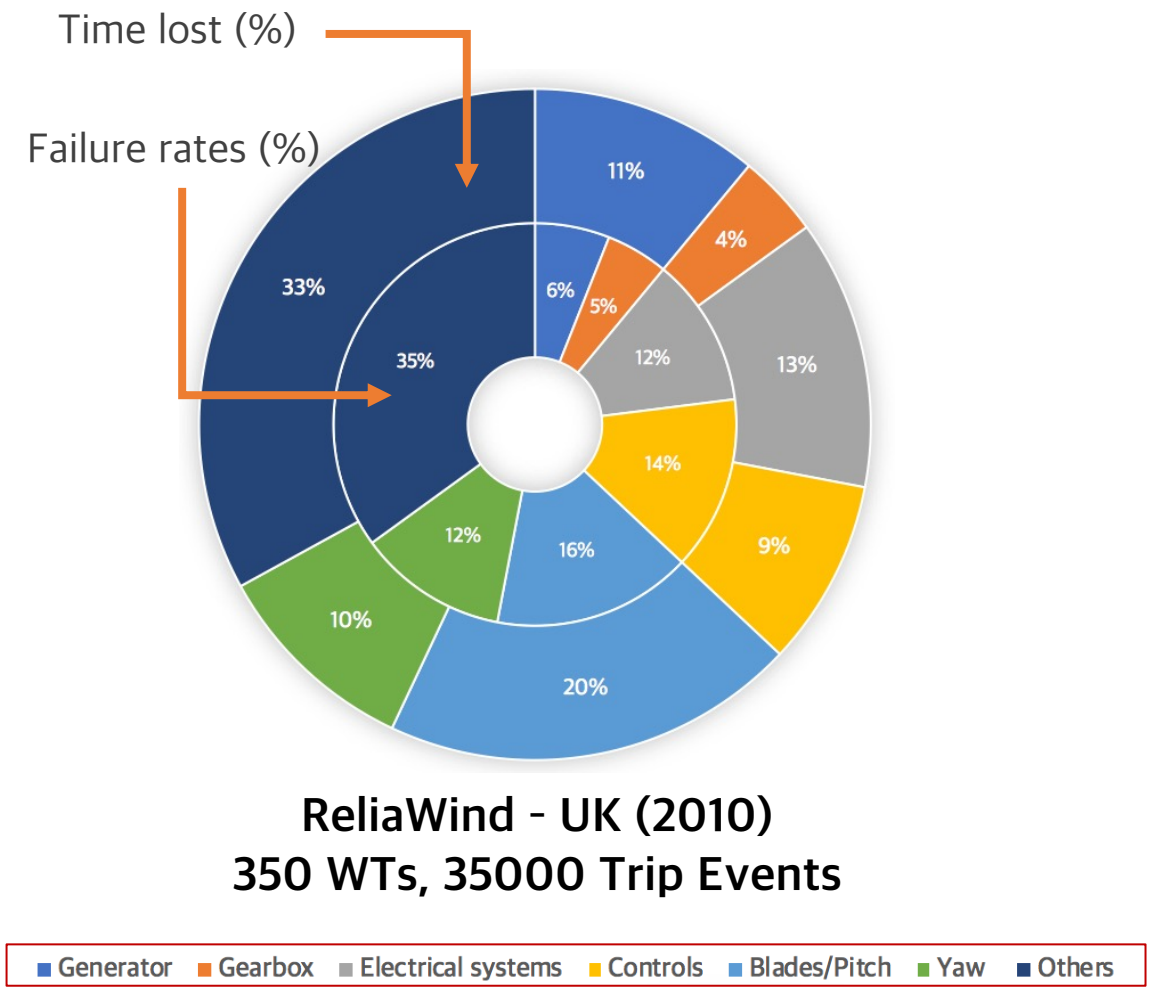
Wind farm asset integrity management

All WTs in a windfarm do not experience similar conditions.

A unilateral decision to extend, repower or decommission is not an optimal solution!

Turbulence intensity, downtime and corrosion are major factors affecting offshore wind turbine life. - *Ziegler et al., IOP J. of Phy. 2016*

Wind Turbine – Faults, Failures and CM



Method	Tower	Blades	Bearing	Gearbox	Generator
Electrical					●
Vibration	●	●	●	●	●
Temperature			●	●	
Acoustic				●	●
Oil-debris monitoring				●	
Operational Parameters				●	●
Strain sensing	●	●			
Fiber optics		●			

Commercial CM systems

Final Publishable Summary of Results of Project ReliaWind, 2011

In summary, it can be said that state-of-the-art CMS and SHM systems are already available in the market …. However, there are hardly any practical solutions available for comprehensive condition monitoring networks of individual wind turbines and entire wind farms.

Rohrig et al. Powering the 21st Century by Wind Energy: options, facts, figures
Applied Physics Reviews, 2019

AIMWind – Research Avenues

Develop essential technologies to ensure ***high profitability during design life*** *and* ***best remaining useful life beyond that period****, improving prospects for lifetime extension and repowering.*

A1. Condition monitoring of machinery and structures

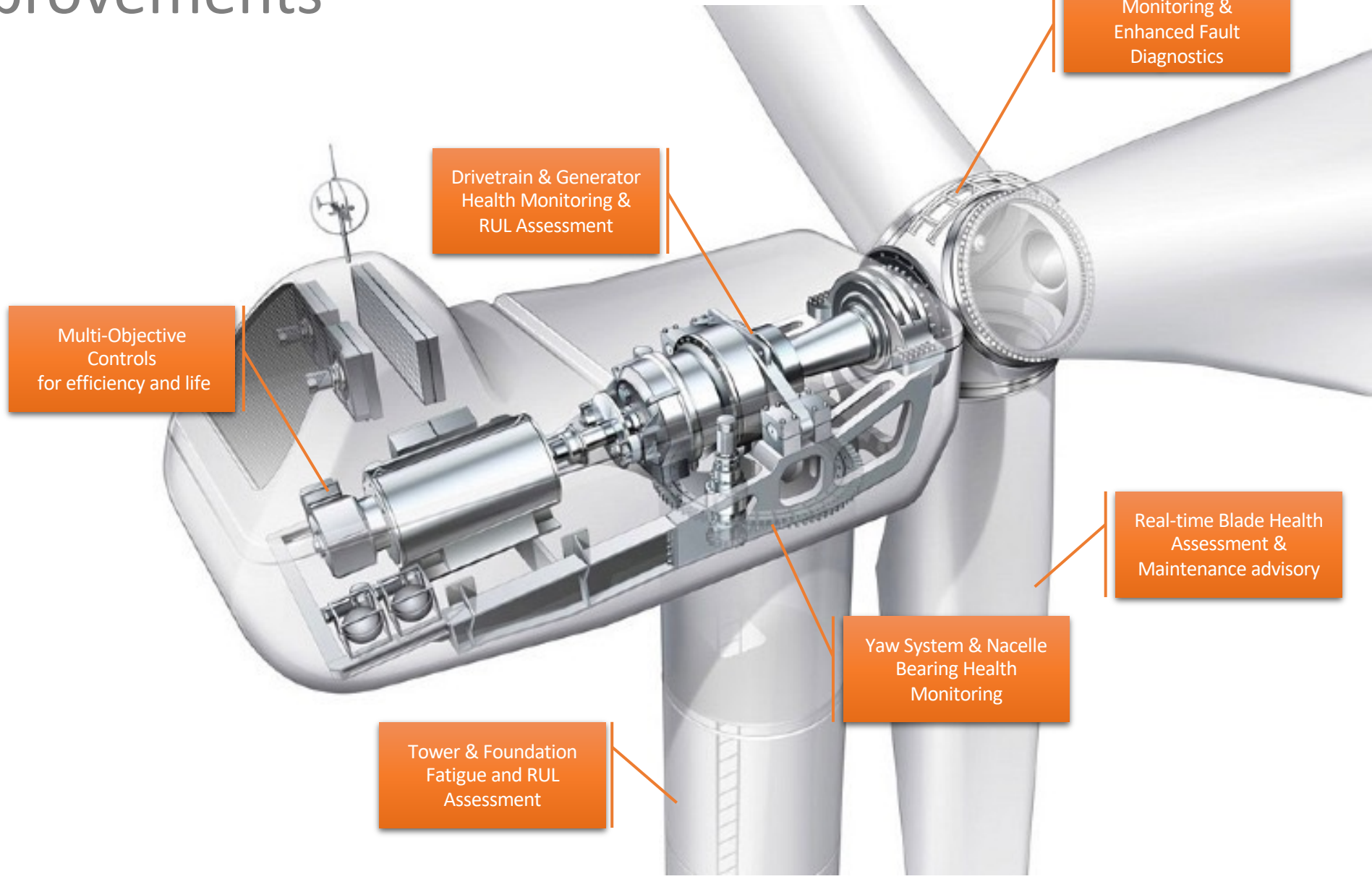
A2. Analytics for health assessment based on multimodal data

A3. Health-aware controls to achieve the dual objectives of life and efficiency in the wind farm operation.

Turbine-level improvements

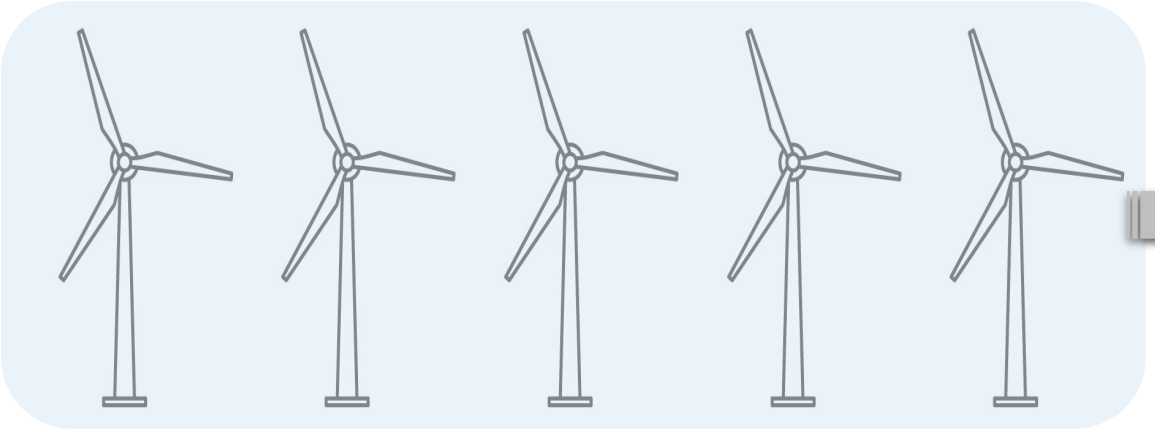
CM systems are presently used as end-products for preventive maintenance.

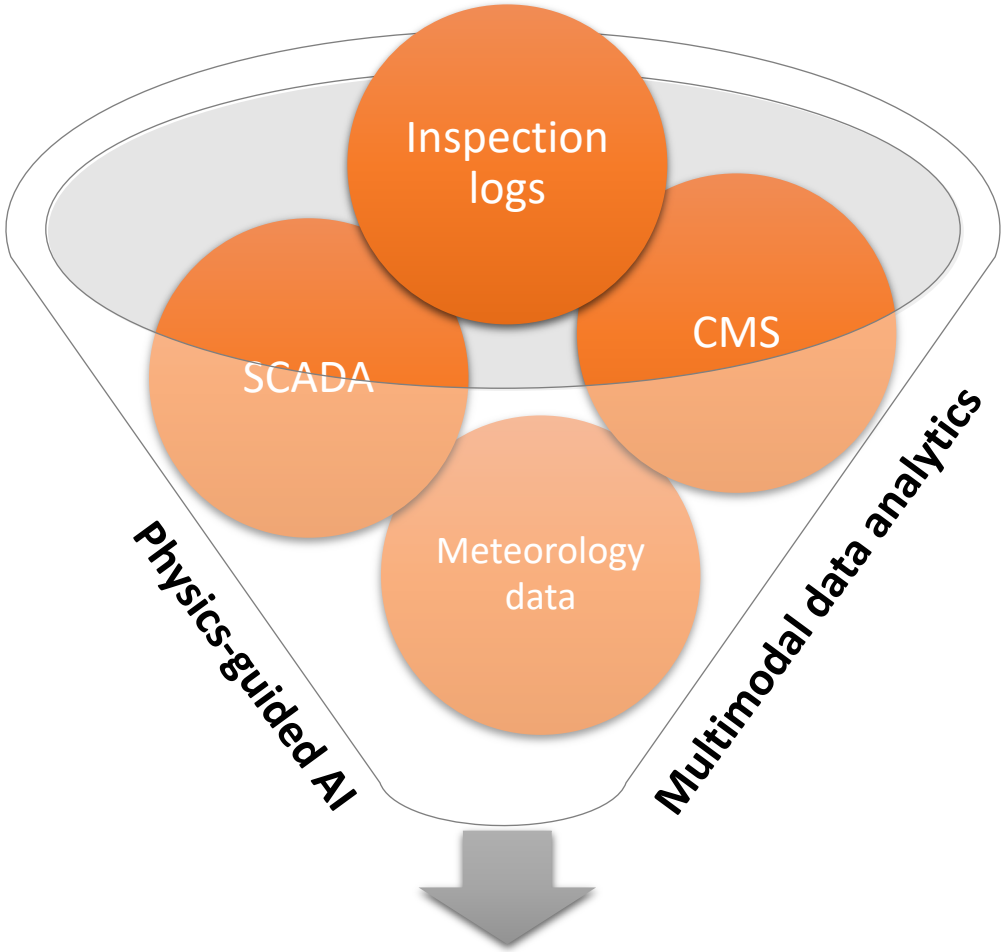
- Extension of CMS for BoP components.
- Enhanced diagnostics with near real-time usage monitoring.
- Structural fatigue and usage monitoring based on wind turbine SCADA and CMS.
- Active corrosion monitoring.
- Assessment of nacelle loads for neck bearing health monitoring.
- Modification of control systems in the presence of fault conditions.



Improved operations and maintenance through analytics

Analytics for wind farm asset management





- Data analytics for evaluation of turbine life based on CMS, SCADA, wind and wave data and inspection logs.
- Improved maintenance advisory through turbine-level remaining useful life assessment.
- Farm-level maintenance optimizations through analytics.
- Leverage farm-level knowledge for deeper insights into individual turbine performance.
- Risk quantification for life extension and repowering.

Wind farm asset management

Real-time RUL | Health-aware control | Lifetime extension advisory

AIMWind group

WP 1 – Turbine component health assessment and RUL estimation

PL – Prof. Van Khang Huynh

WP 2 Low-cost solutions for wind turbine structural health monitoring

PL – Dr. Rune Schlanbusch

WP 3 – Analytics for wind farm health assessment

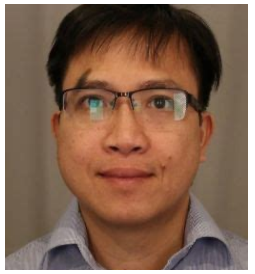
PL – Prof. Christian Omlin

WP 4 – Health-aware wind farm control

PL – A Prof. Riccardo Ferrari

Project management & research supervision

Prof. Kjell G. Robbersmyr, Dr. S.T. Kandukuri



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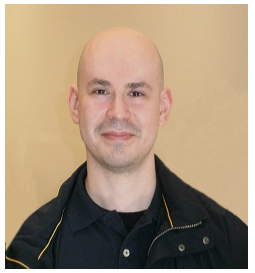

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Even Skretting (Finance)

Francesco Vanni DNV(Advisory)

SMI

- Steering research directions
- Wind turbine data
- User stories
- Evaluating our research
- Testing software products
- …

Thank You

www.aimwind.no

Surya Kandukuri

Sr. Data Scientist
Smart Maintenance

Post-doctor

COGNITE

UiA