HYPERWIND

Failure Detection & Prediction

FD&P MODULE

CONTEXT

Renewable energy producers are facing today the decrease of their feed-in tariff while their LCoE (Levelized Cost of Energy) remains constant or even increase. For wind farms the operation and maintenance costs is a large part (up to 40%)[1] of the LCoE. In this context, wind farm managers are strongly interested in optimizing their maintenance operations and minimizing their costs.

A significant part of maintenance costs can be imputed to corrective maintenance operations. This is due to the fact that many wind turbine failures occur suddenly, so that required spare parts and logistical means are not provisioned, or are detected too late, when wind turbine damages are really important. Also, for several failures, a correct diagnosis can be very difficult and requires a lot of time and very specific competences.

Even little improvement in early failure detection or in failure prediction, or support in failure diagnosis can have a significant impact on cost control.

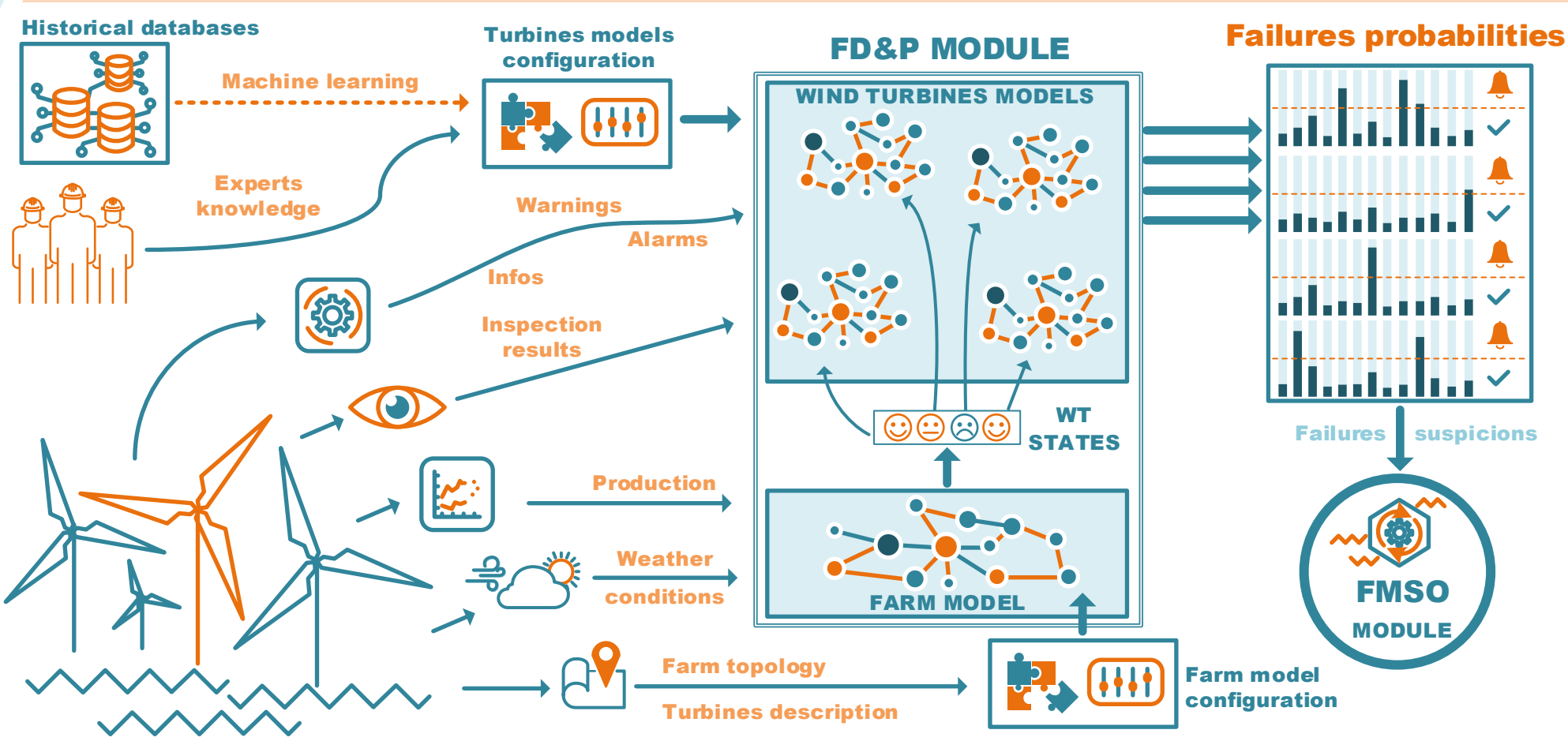
OBJECTIVE

Offer to wind farm managers as much support as possible for automatic failure prediction, detection and diagnosis.

BENEFITS

- Enable an early detection of several types of wind turbine failures
- Support and help maintainers during failures diagnosis
- Improve wind farm operational capacity

HOW IT WORKS



Wind Turbine model

Configuration

Experts knowledge

- ✓ FMECA (Failure Modes, Effects and Criticality Analysis)
- ✓ Correlations between failures and SCADA outputs (info, warnings, alarms)
- ✓ Technical characteristics of wind turbine components (MTBF, etc.)
- ✓ Health state of turbine's components
- ✓ Patterns that may be present in wind turbine monitoring data and that may suggest a possible future failure

Relevant historical databases

- ✓ Machine learning techniques can be used to search for patterns that suggested old failures, if wind turbine monitoring data is correctly adnotated and correlated with the history of failures detection and maintenance operations

Inputs

SCADA, CMS & CMMS data

- ✓ Wind turbine controller logs (time series of infos, warnings and alarms)
- ✓ Wind turbine's monitoring data

Inspection results

- ✓ Indicate the health state of turbine components, when such an assessment is possible (ex. spare part remplacement)

Output

- ✓ For each wind tubine WT and for each type of failure F, the probability that the wind tubine WT is affected by the failure F

Model strengths

Dynamic probabilistic model - can be used to estimate the probability of each failure at the current time but also can be unrolled and used to predict how these values will evolve over time

Farm model

Configuration

- ✓ Farm's topology
- ✓ Turbine's relative positions
- ✓ Turbine's power curves

Inputs

- ✓ Weather conditions for a given time interval
- ✓ Productions of each turbine for the same time interval

Output

- ✓ A quantitative estimation of the global health condition for each turbine

Model strengths

It allows to exploit the correlations between the wind turbines to detect anomalies

[1] *Observatoire des coûts de l'éolien terrestre*, PÖYRY and FEE (Oct. 2016)

Version A

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