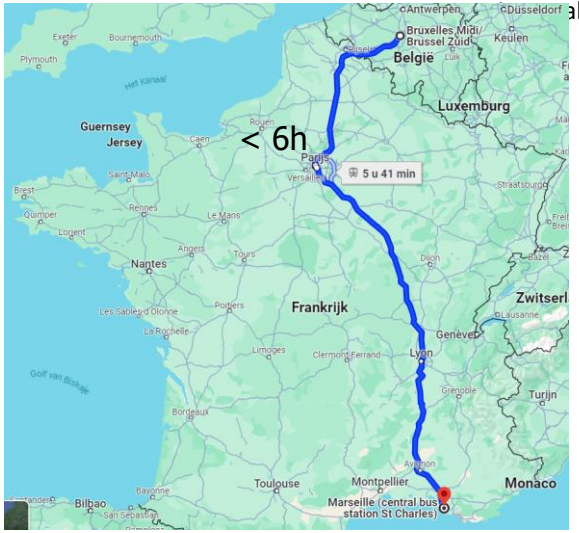
Open-Source and DevOps for WindPower

FOSDEM conference 2024, Brussels

Marco Berta, Data Scientist in ZF Wind Power Digital team

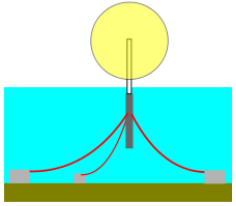
Marco.berta@zf.com

Energy transition example: Marseille



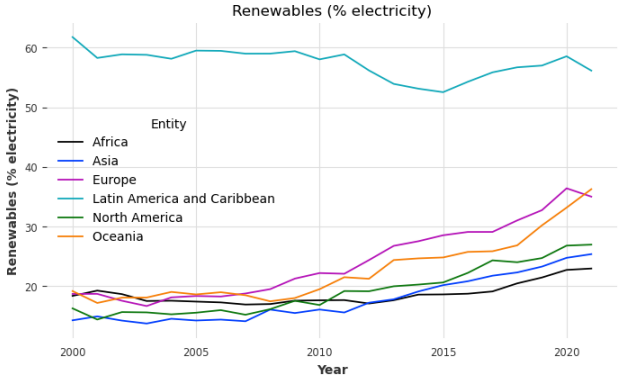
Source: Google maps

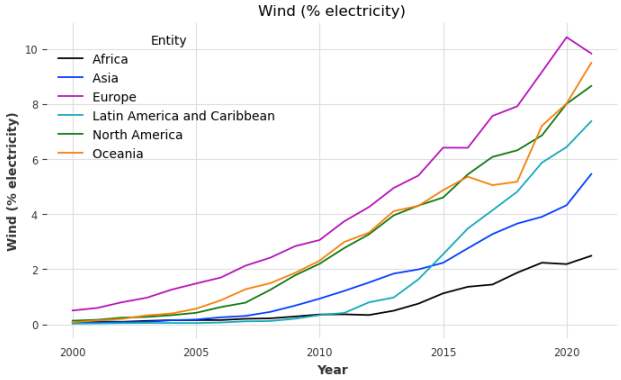
Source: openstreetmaps

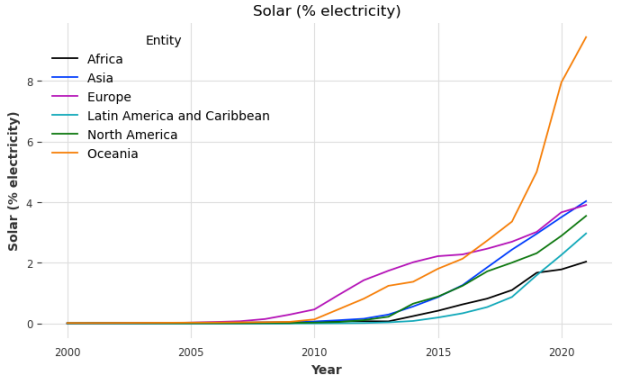


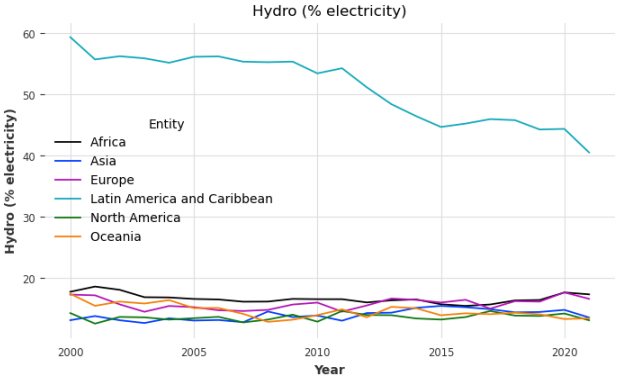
Source: Wikipedia WindFloat_Prototype

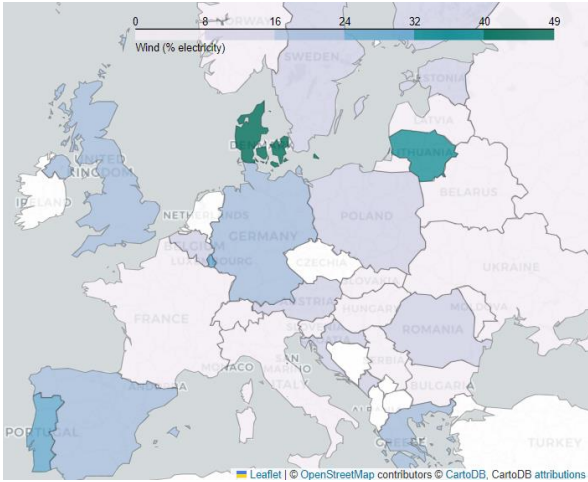
Wind: leading renewable energy in EU





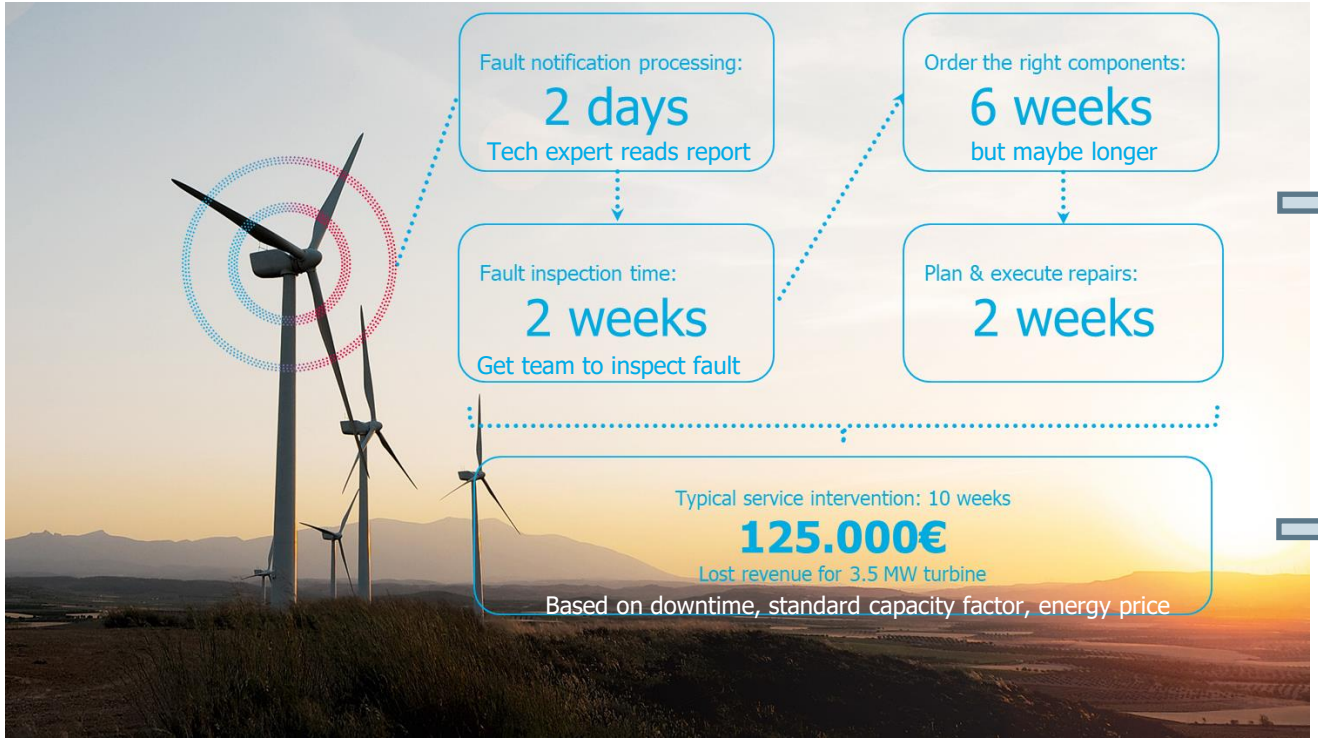






Wind power more important than solar here in EU, stats from open data. Source: [Global stats visualization & local forecast | Kaggle]

But.. When something goes wrong?



Intervention is a major issue, having the spare parts at the right time saves money!!!

Example from the field

Monitoring and predicting

ALERT

WHAT?

- Failure classification based on gearbox and bearing expertise
- Repair solution

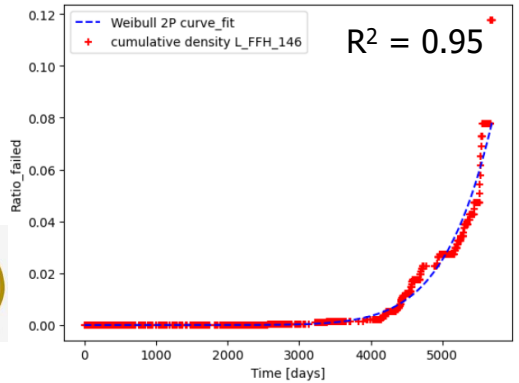
WHERE?

- Spare parts location
- Turbine location

WHEN?

- Reaction horizon
- Spare parts availability
- Technician availability

Data collected and analyzed

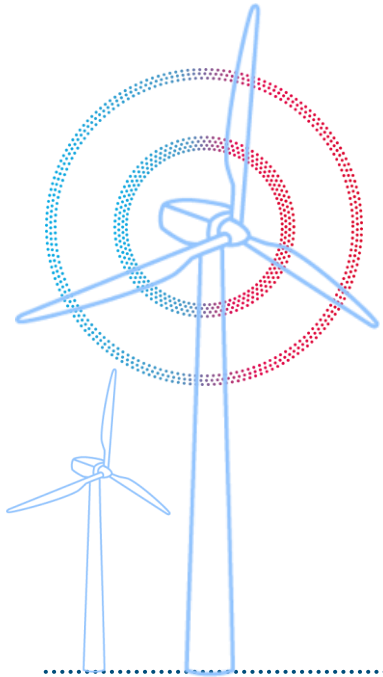


Weibull model to predict failures occurring / spares order

$$F(x) = \begin{cases} 0 & \text{for } x < 0, \\ 1 - e^{-(x/\beta)^{\alpha}}, & \text{for } x \geq 0. \end{cases}$$

Model verified on test data,
Eventual outliers discussed with domain experts

Fast return to operation



Wind turbine data

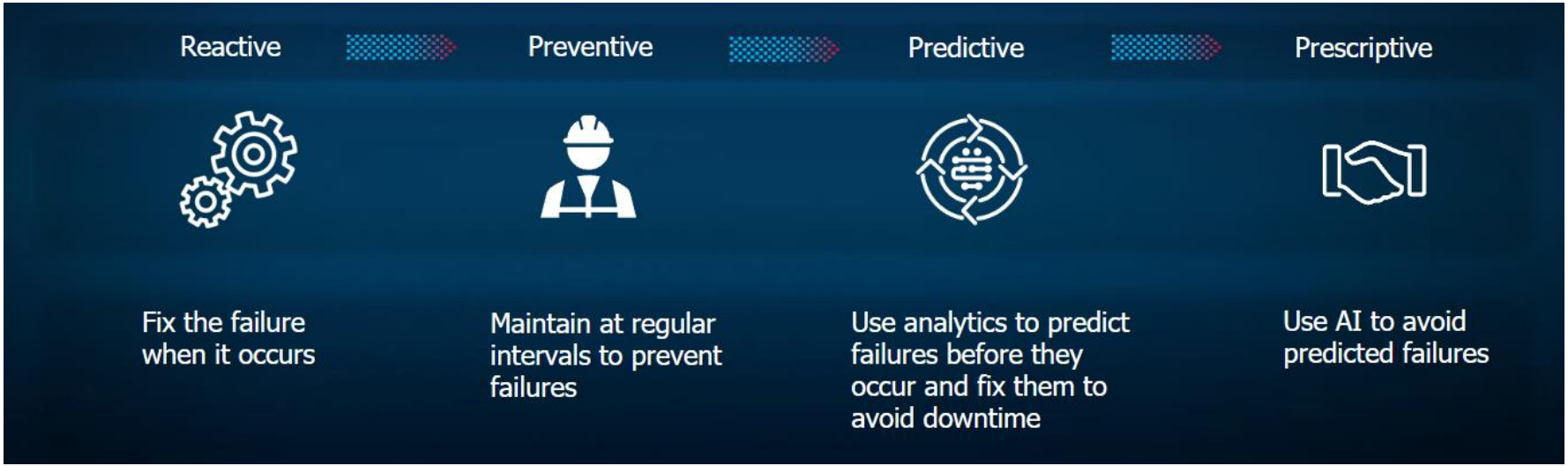
Cloud integration

Prescriptive maintenance

Production data

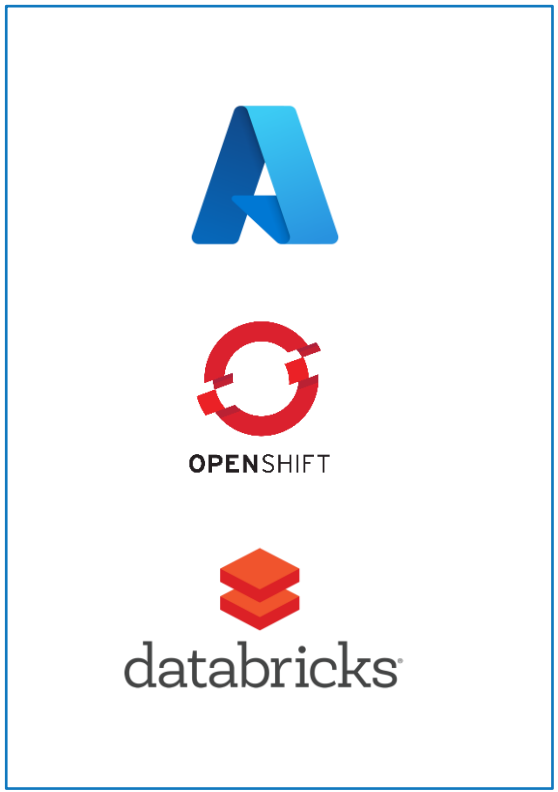
SEE THINK ACT

The evolution of maintenance

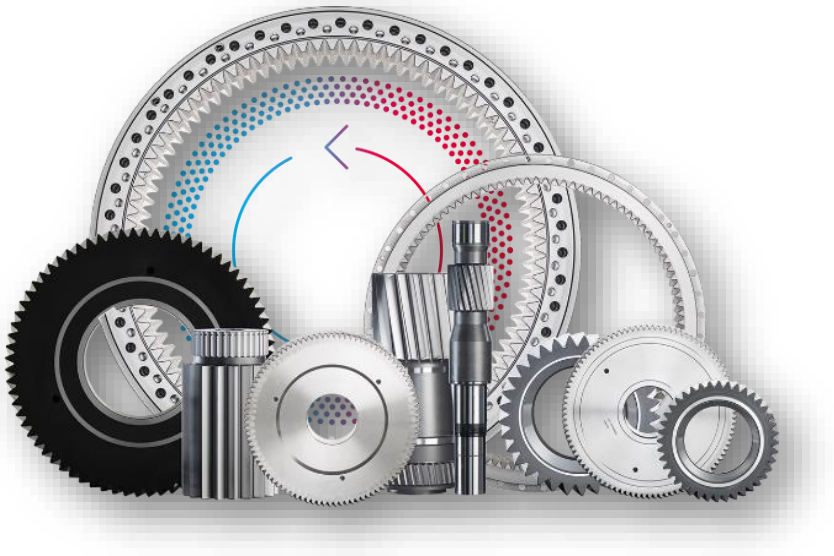


Data analysis with open-source software allows more and more sophisticated maintenance

ZF Wind Power Digitalization tech stack



Desired Outcome from data analysis



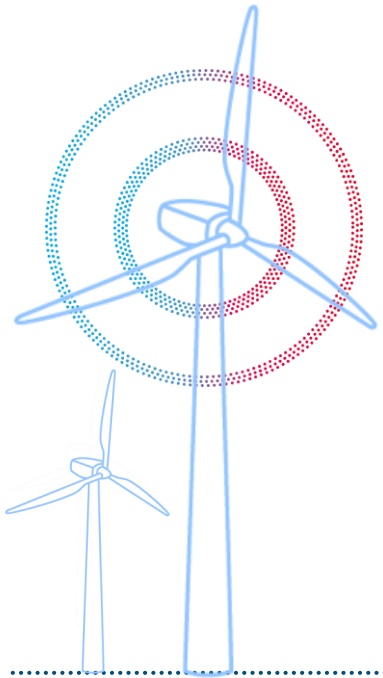
Reduced downtime
by having the right parts at the right time

Reduced costs
by optimizing the stock levels

Reduce unplanned maintenance
with proactive planning

Avoid consequential damage
by addressing reoccurring failure modes

Realized improvements in pilot study



↓ 50%
Alert processing effort

↓ 60%
Unplanned field inspections

↓ 85%
Lead time to repair

↑ 0,4%
AEP at park level

Conclusions

- **Fragmented value chain conversely affects wind energy efficiency**

- **Data insights and prompt communication has a big positive impact:**
  - Reduced alert processing effort
  - Prescriptive maintenance
  - Lead time to repair decreased
  - Increased overall efficiency

- **Good results could be achieved using open-source software running either on premises or in the cloud**

- **DevOps practices allowed the pilot project success**

Thank You!

Marco Berta, Data Scientist in ZF Wind Power Digital team

Marco.berta@zf.com

Spare parts optimization