DEIF Introduction in Lakeside Park

Klagenfurt, 2020-12-15

DEIF

Since 1933
Privately owned

Skive, Denmark
Group headquarters

19
Global offices

+600
Employees

Wind power | **Marine & offshore** | **Land power**

OEM: Controller, Converters, Electronics
5% global market share – China, Europe, Brasilia, India

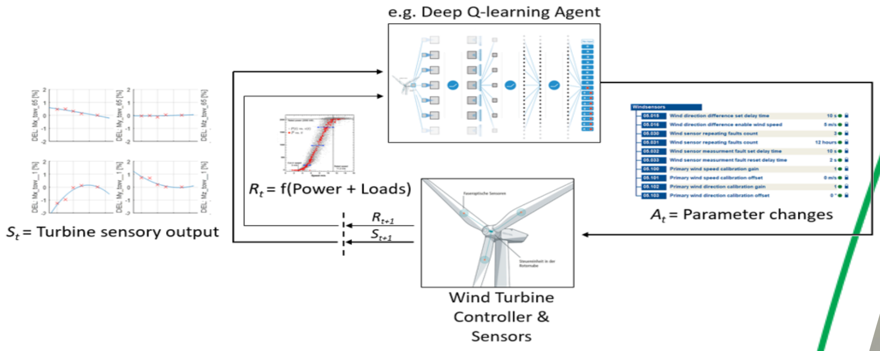
Leading in Retrofit of Control System
>2000 Wind Turbines retrofitted, offerings for Repower Design (Senvion*, Dong Fang*), Vestas*, Suzlon*, Enercon, Nordex, …

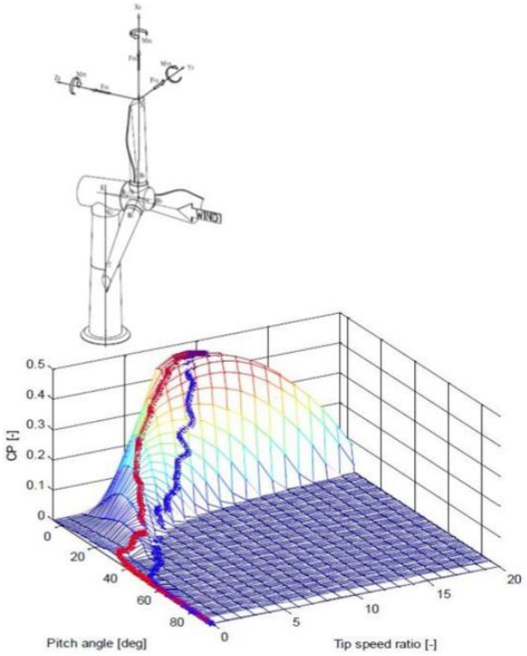
DEIF in Lakeside Park

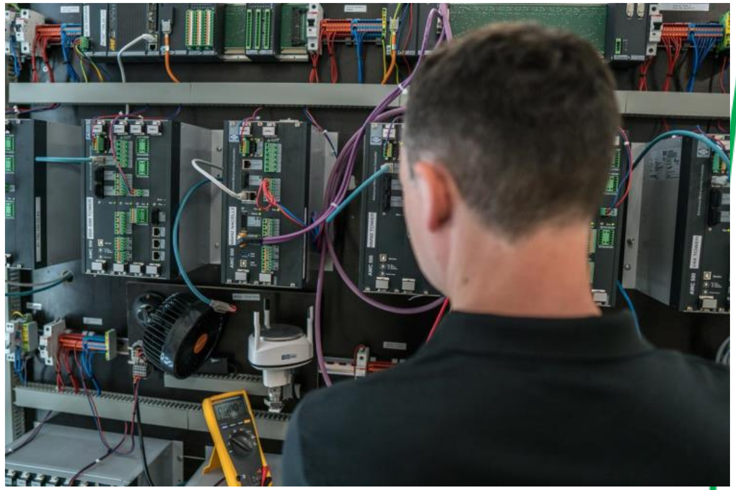
Global Competence Center for

- Asset Upgrade & Wind Business
- Data & Machine Learning

Focus on Software Development, Business Development, Management







Retrofit Focus: Wind Park Owner

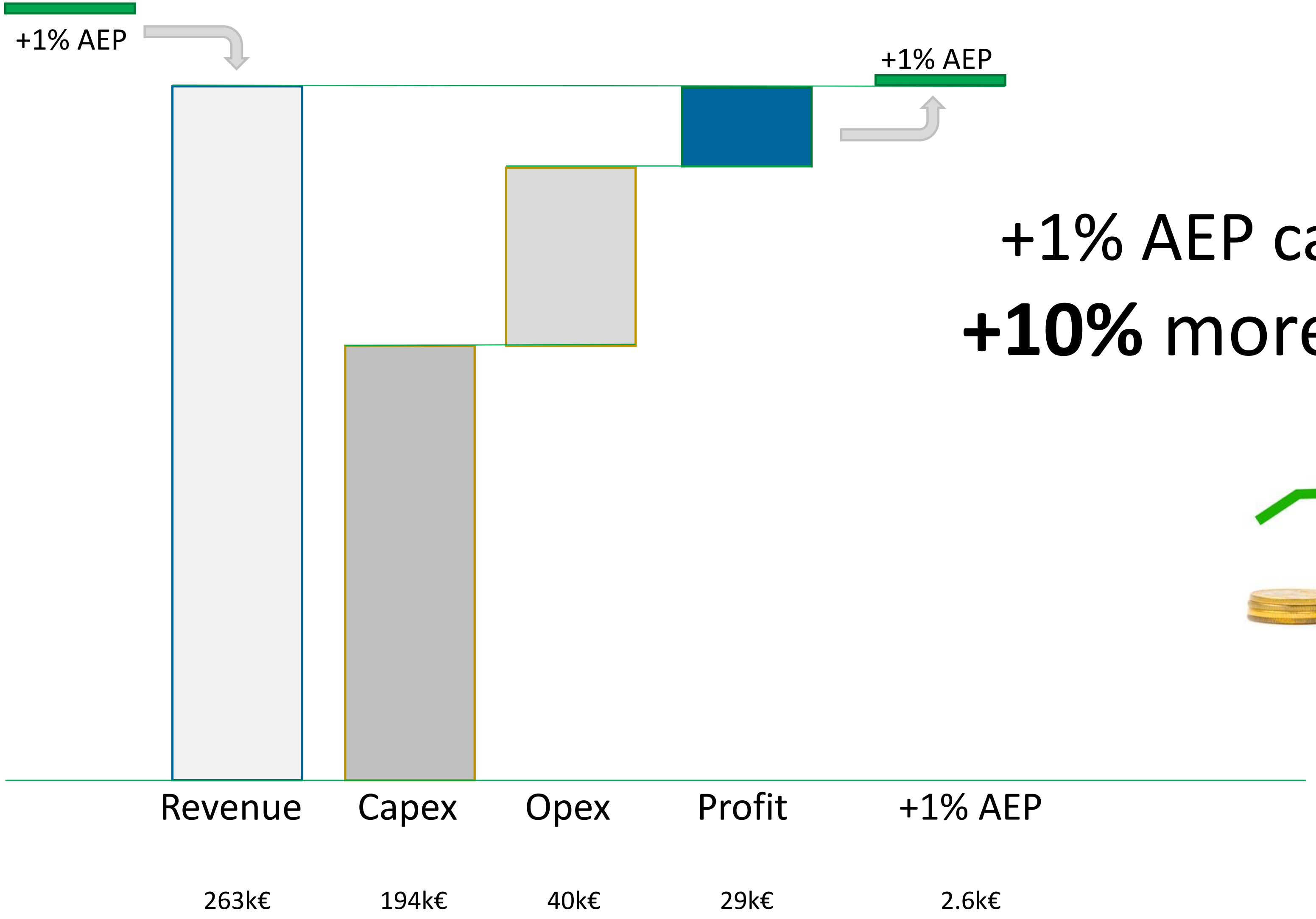
We deliver

- New Control Software for Old Wind Turbines
- New Control Systems for Old and New turbines
- Electric Systems
- Analysis & Reporting Services
- Wind Turbine Engineering Services

Maximal benefit for IPP

1) Flexible service & maintenance – stay free
2) Full access to all data – you are the owner
3) Site Specific Optimizations – gain the maximum

What means **+1%** AEP (Annual Energy Production)?



+1% AEP can add

+10% more profit

Assumptions:
WTG - 2MW
Capacity Factor - 30%
Market price - 50€/MWh
Initial Investment - 2M€
Return Period - 13 years

The Difference of DEIF in Wind Power

DEIF
Maximise your business

Full Re-engineering of the Wind Turbine!

- Load Calculations,
- Aero-elastic Modelling,
- Control Engineering,
- Data Analysis,
- Lifetime Optimizations,
- Electrical Design,
- Turbine Optimizations & New Functions like De-icing,
- etc. …

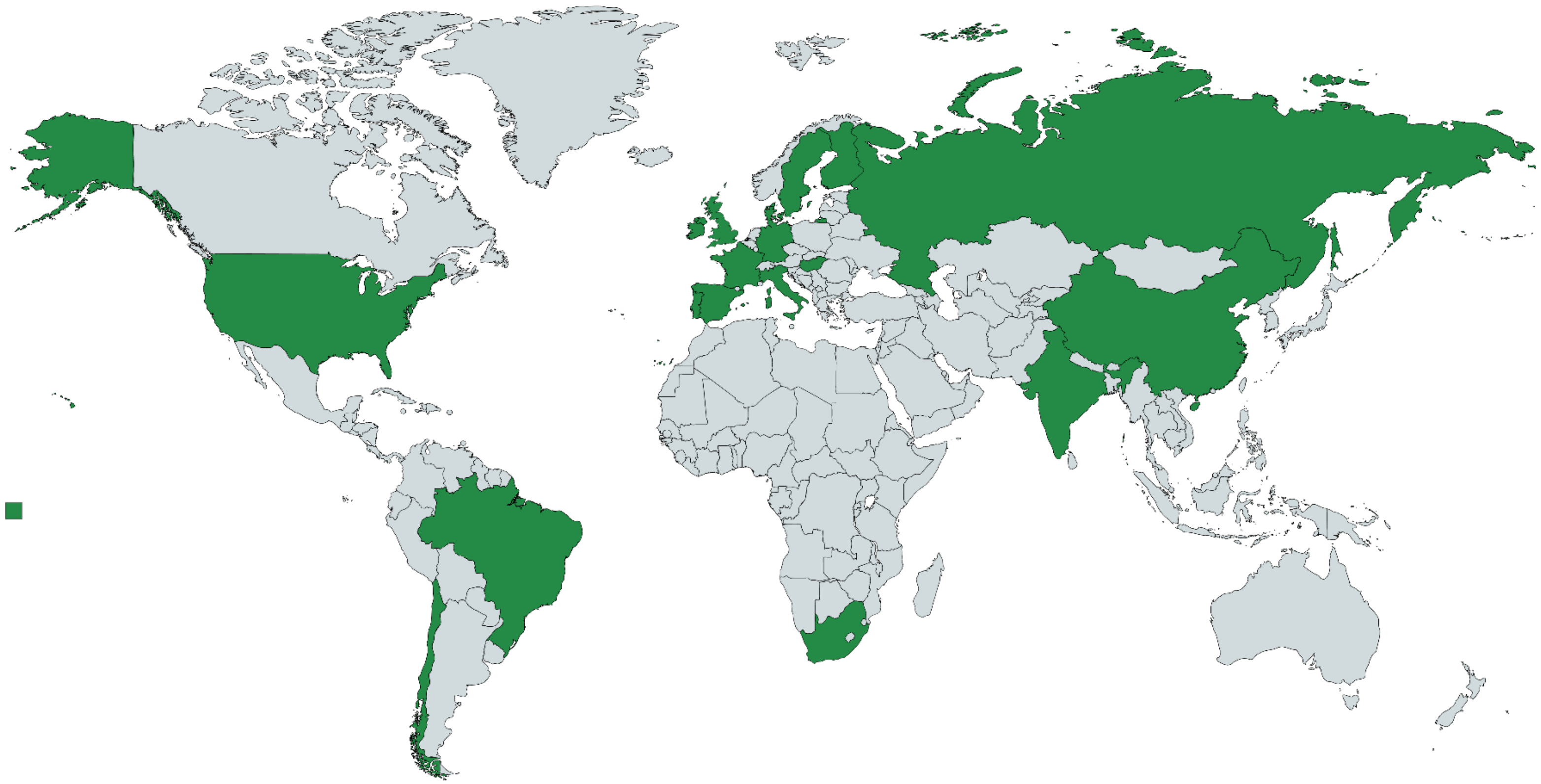
Technology Support Organization – replace OEM

More than 30 engineers, experience in turbine engineering of…

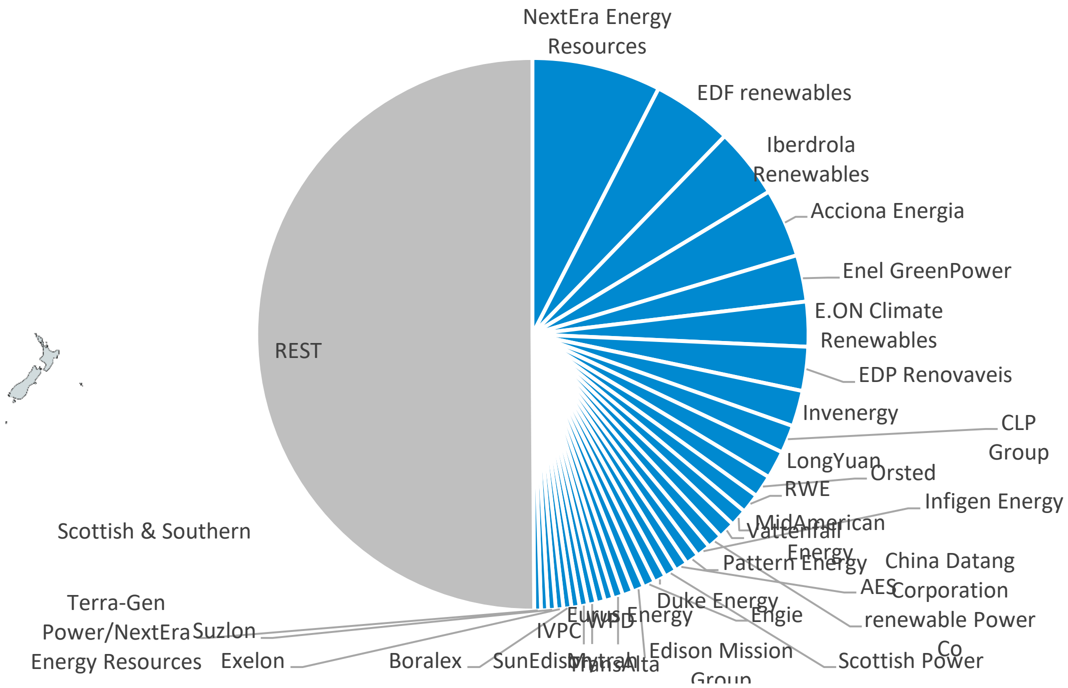
Vestas
SENVION wind energy solutions
SIEMENS Gamesa RENEWABLE ENERGY
RRB ENERGY
SUZLON POWERING A GREENER TOMORROW
HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Fuhrländer
ENERCON ENERGIE FÜR DIE WELT
DOOSAN
INOXWIND Energizing INDIA
SINOVEL 华锐风电

Markets with DEIF Wind / Klagenfurt Installations

DEIF Software from Klagenfurt - already installed



Wind Farm Owners – Potential Market



Self Learning Wind Controller

Research Project with support of FFG and KWF

Improving Wind Turbine Controls

- **Increased performance = increased energy production**
- **Increased energy production vs. mechanical loads**

What we do today:

- Manual tuning and validation per individual turbine

➢ Resource intensive – not economic for bigger fleet

The path to success:

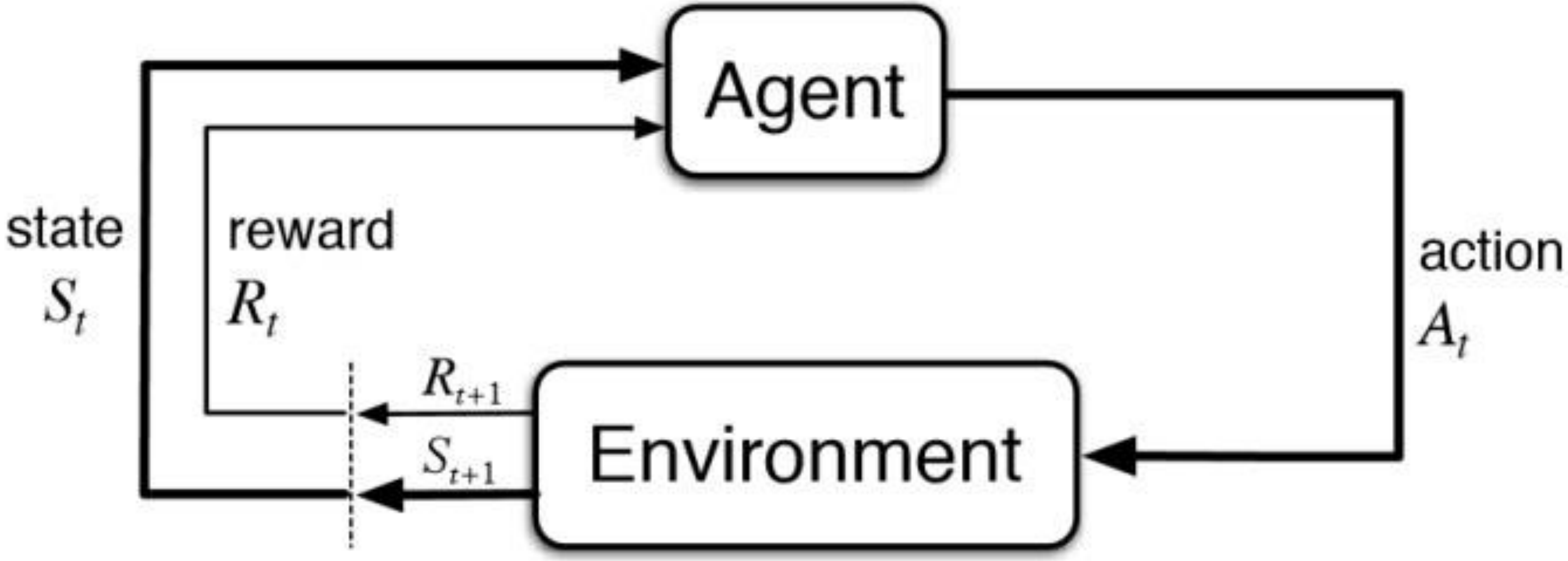
❑ Enhance data acquisition and cloud processing

❑ Introduce AI based algorithms for self-optimizing controllers

❑ Introduce model based (load) validation

➢ Have a controller which self-optimizes AEP of individual turbine

Reinforcement learning for Wind turbines

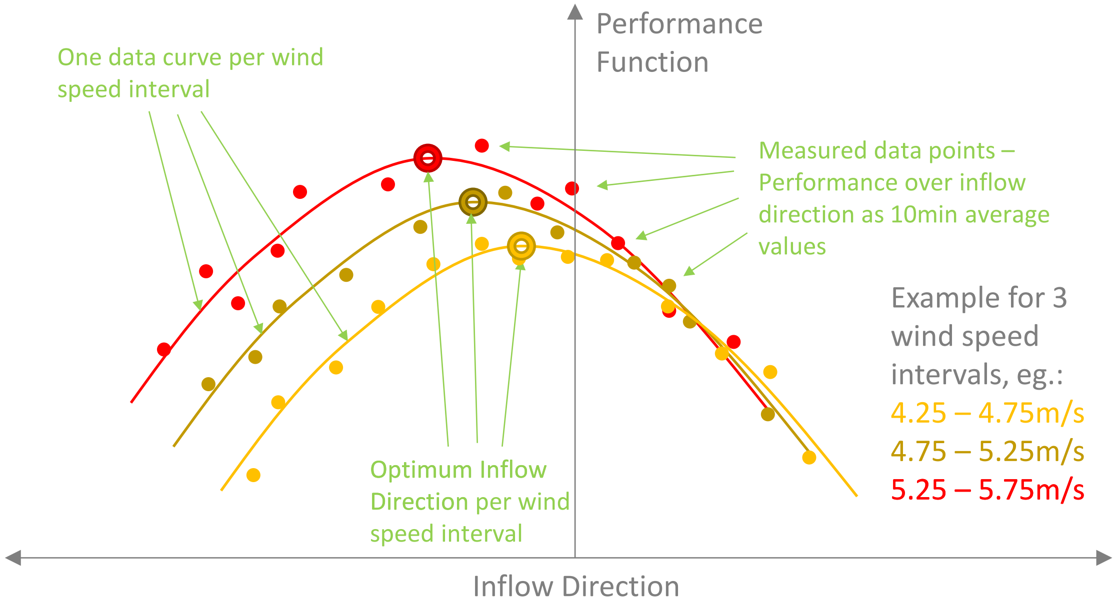


Sensors

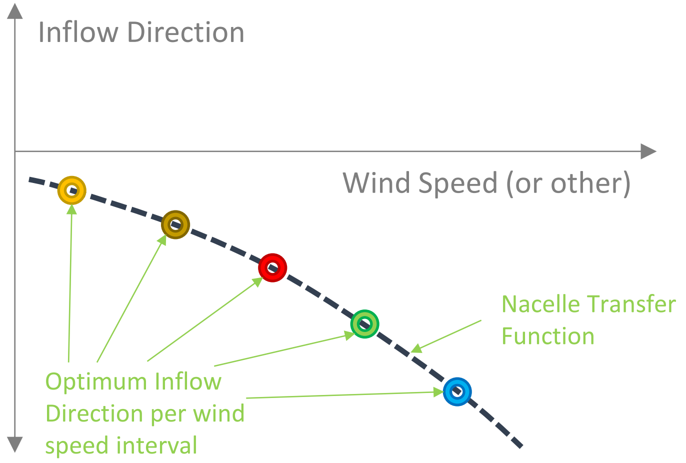
Use Case: Inflow Optimizer

- Automatic detection and calibration of the optimum yaw angle (wind attack position)
  - Usage of change of wind direction due to wind turbulence, no forced yaw maneuvers
  - Analysis of the inflow direction leading to optimal performance
- Optimum position depends on production situation (rotor speed, output power, pitch angle, ...)
  - The calibration is done depending on the turbine operation point (wind speed binning with intervals of 0.5m/s). The result of that analysis is the „Nacelle Transfer Funcion".
  - The Nacelle Transfer function can be computed in dependency of wind speed, rotational speed, output power or other variables (depending on turbine type).
- Calibration is done independendly for every wind sensor. This way sensor failure and sudden sensor offset are covered.
- Possible performance increase ~2%
- Explored as part of a Master Thesis Project by our AAU intern Nataša Rašeta

Analysis of Optimum Inflow Direction per Wind Speed Interval:



Result – Nacelle Transfer Function:



Potential for Cooperation

Market Intelligence, Market Approach

- Energy Markets Globally
- Renewables

Technology – Knowledge Exchange

- AI / self optimizing systems
- Software platforms
- Cloud / Data services

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