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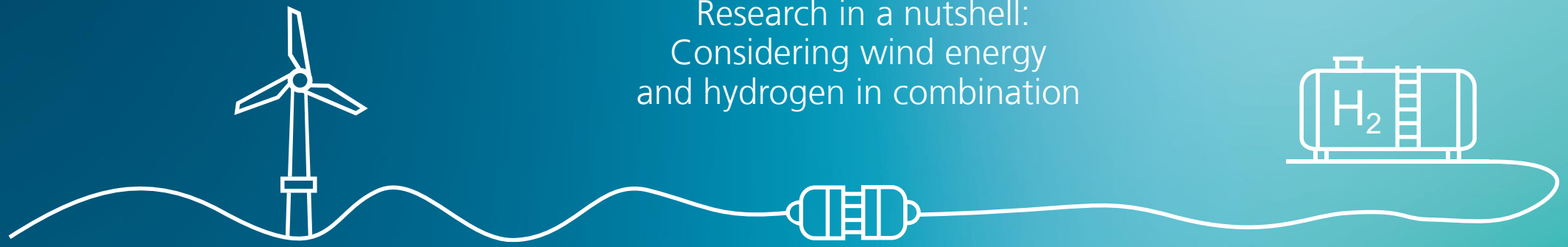
Research in a nutshell:
Considering wind energy
and hydrogen in combination



2023/05/11/ International RAVE Workshop

RAVE-Project FlexiWind – Modelling of Virtual Offshore Wind Farms Regarding Flexible Operation and Optimization of Structural Loads and Performance

Johannes Fricke (IWES)

General Project Overview

General Overview

FlexiWind Project

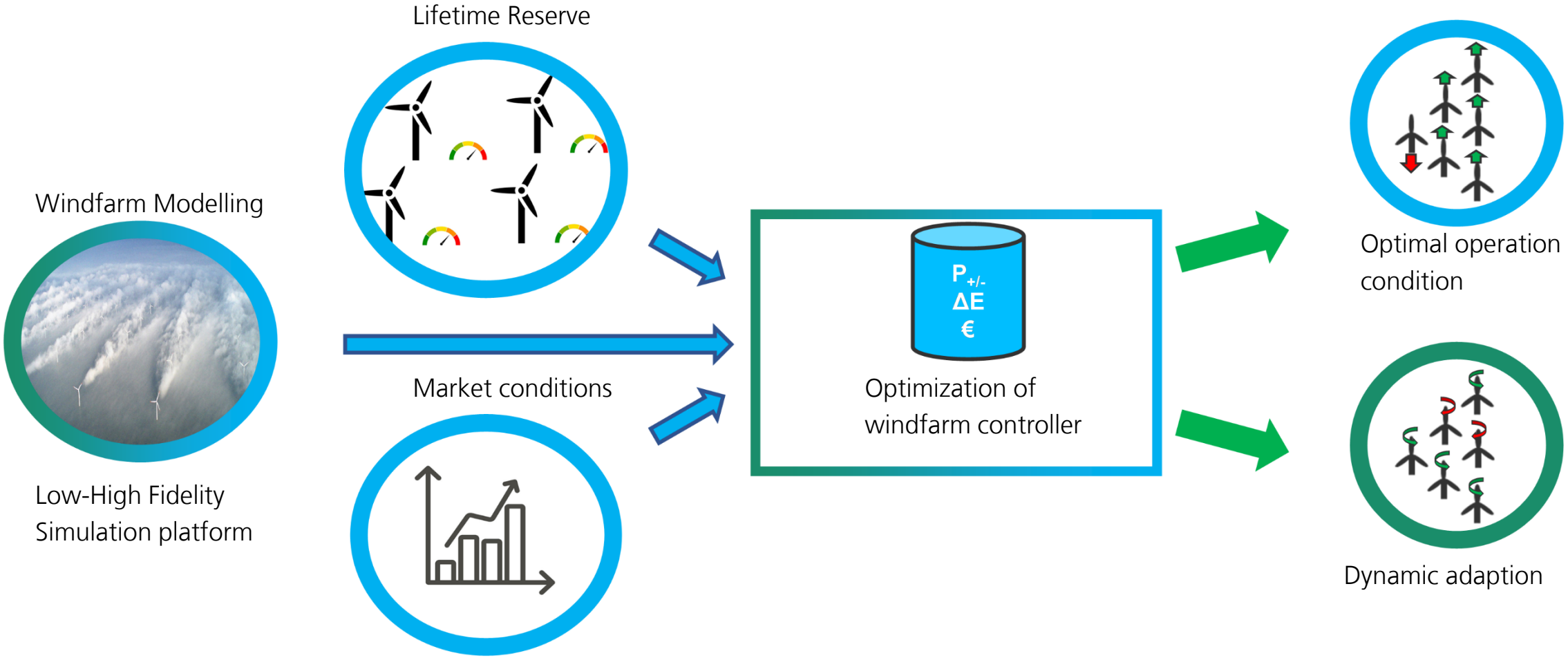
Requested Budget: about 2.5 Million €
Duration: 3 years
Project start: November 1st 2022

Project Lead: Fraunhofer IWES
Funded partners: Stuttgart Wind Energy (SWE), Ramboll (RBL)
Associated Partners: GE, Iberdrola, Beckhoff

Projektträger Jülich
“7. Energieforschungsprogramm” - BMWK

General Overview

Diagram about the whole project



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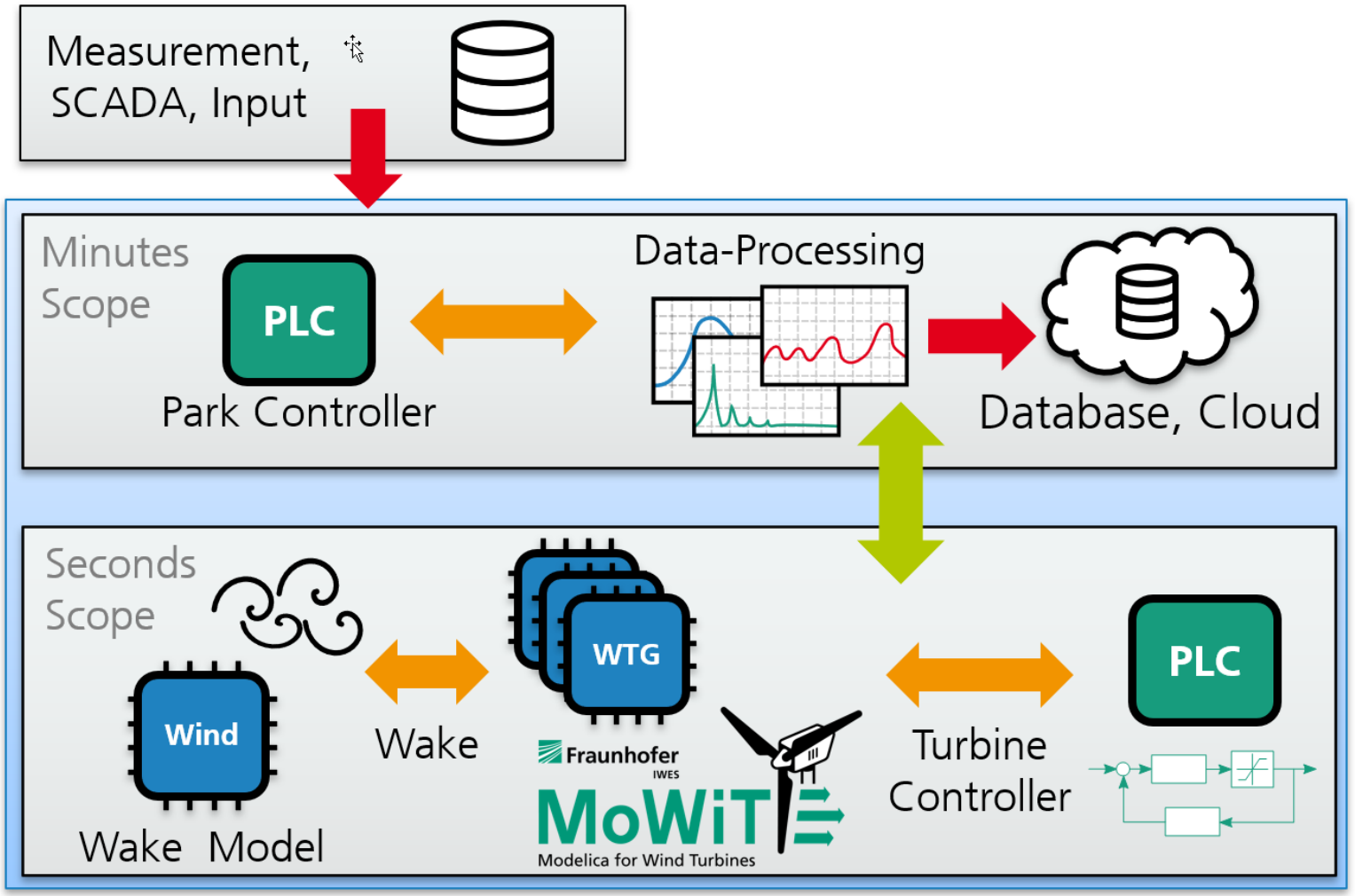
General Overview of wind park simulation platform



Input data (from RAVE, GE, Iberdrola)

Components of Wind Farm Simulation Platform (together with Beckhoff)

Minutes Scope: Optimization of wind farm control

Seconds Scope: Flow and Wake Modelling, Load Simulation and Lifetime Estimation, Wind Turbine Control

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Optimization of FOWT systems

MoWiT – Modelica® library for Wind Turbines[1]

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MoWiT

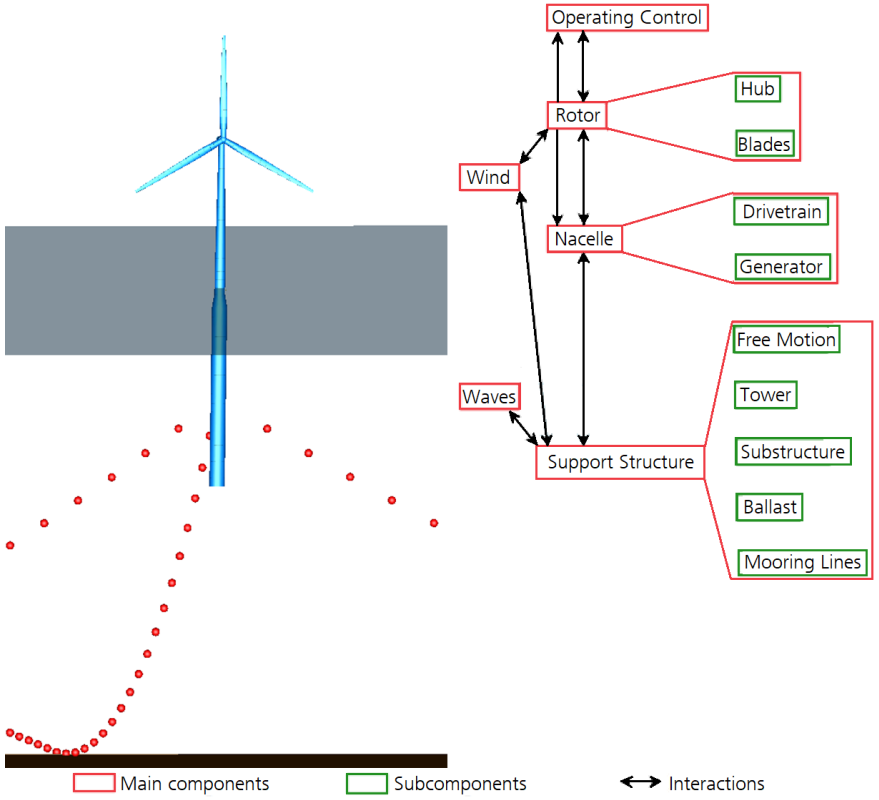
Modelica® Library for Wind Turbines

Computational model for wind turbine load calculations

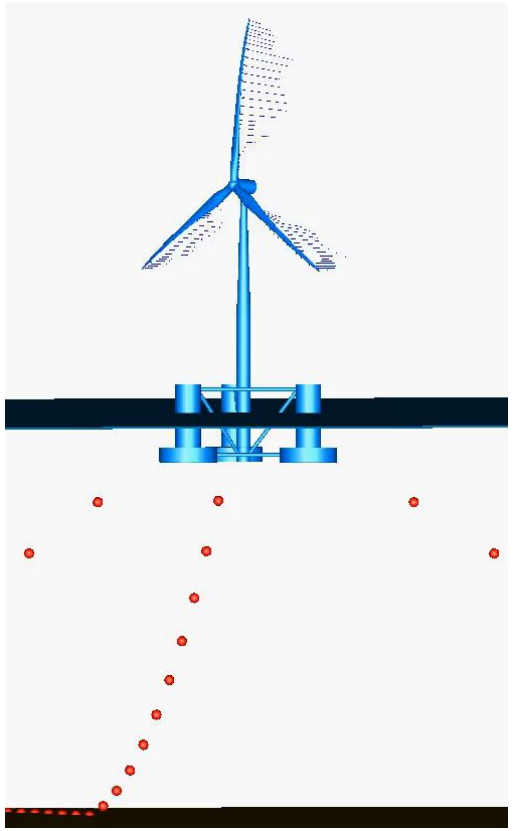
- Modeling of any state-of-the art wind turbine system
  - Onshore
  - Offshore bottom-fixed
  - Offshore floating
- Fully coupled multi-physics simulations
- Loads and system dynamics in time-domain

Object-oriented & component-based

- Flexible multibody approach based on Modelica Multibody Library
- Verified and Validated
- Real-time capability for hardware-in-loop
- Interfaces to C, Matlab/Simulink, FMI/FMU
- Open Source in 2023



Adapted from (Leimeister et al., 2017, doi: 10.3384/ecp17132633)



[1] www.mowit.info

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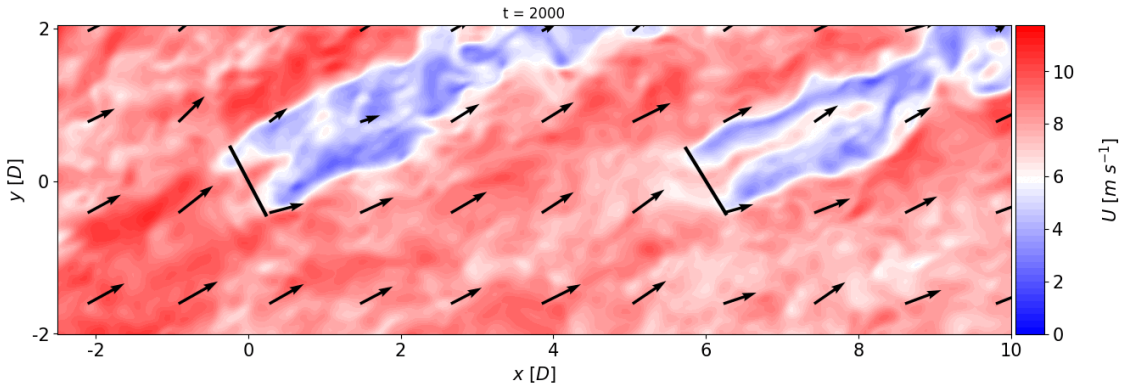
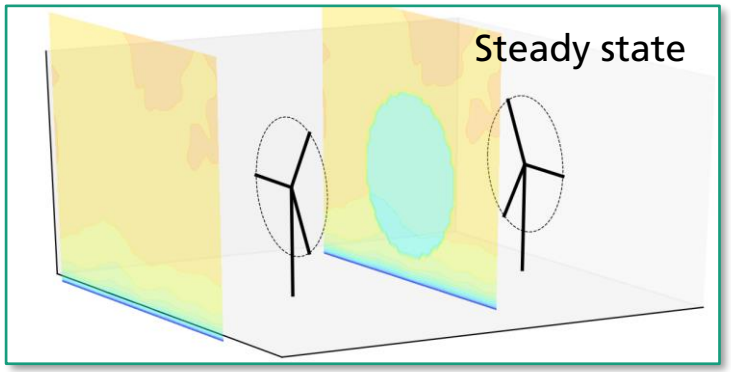
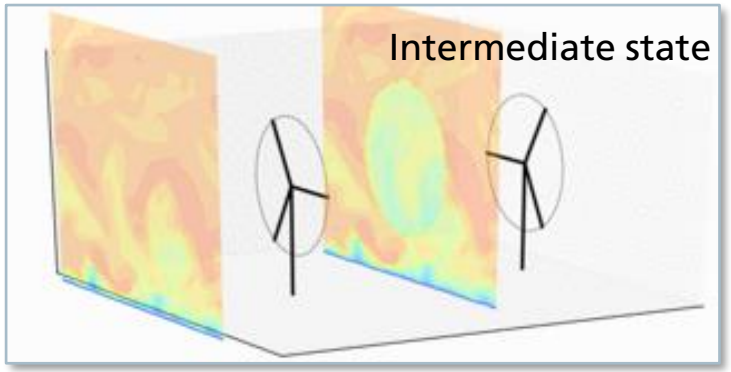
Aerodynamic interaction

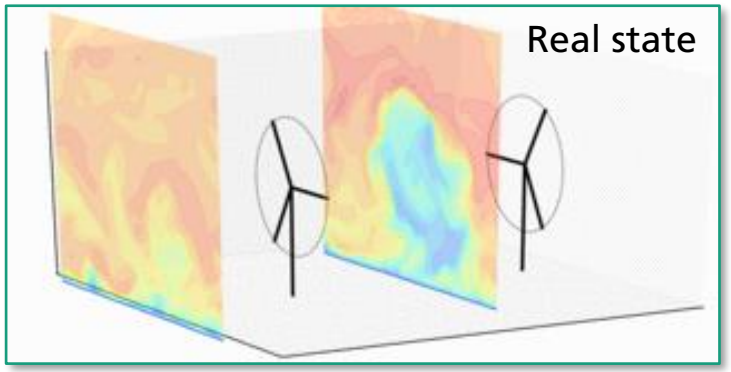
Wake mitigation / control

- Create reference LES data set for various inflow conditions
- Implement aerodynamic interaction between turbines for the simulation platform
- Search for a *sweet spot* as compromise between wake detail and model performance









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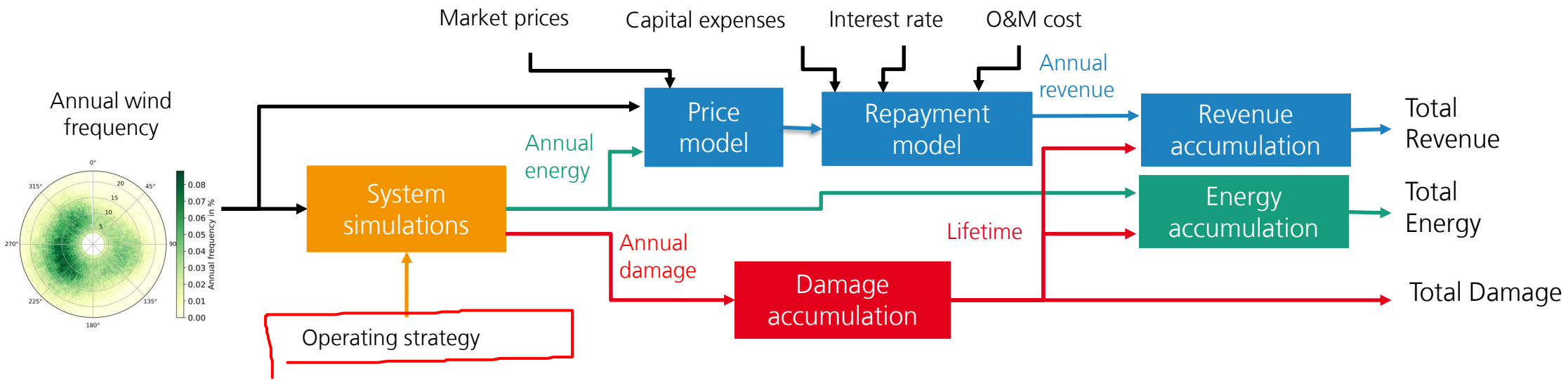
Operational optimization

Goal: **Maximize revenue from existing components**

Approach: **Model-based optimization for all operating conditions over full lifetime**



Challenge: **Aging of all components must be taken into account**

Result: **Planned operation of all turbines for entire lifetime**

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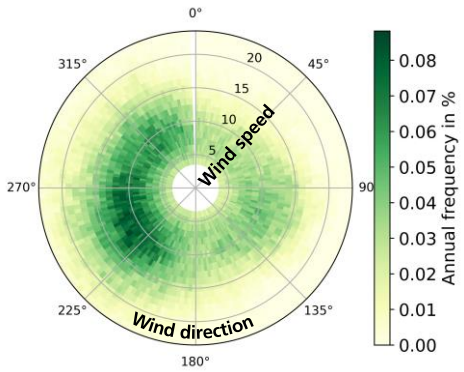
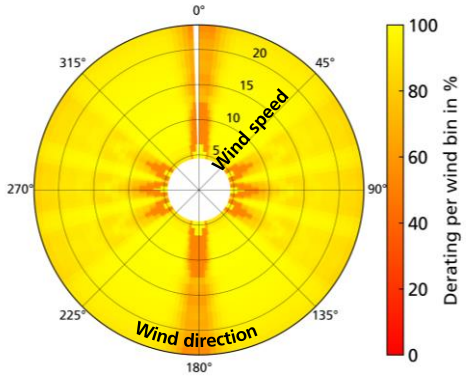
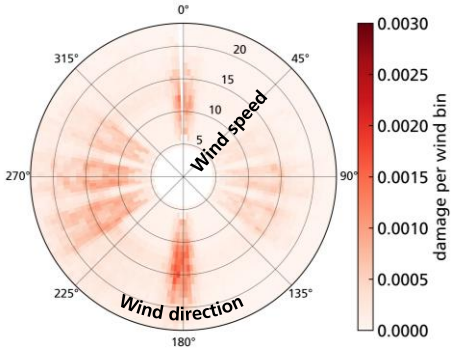
Operational optimization



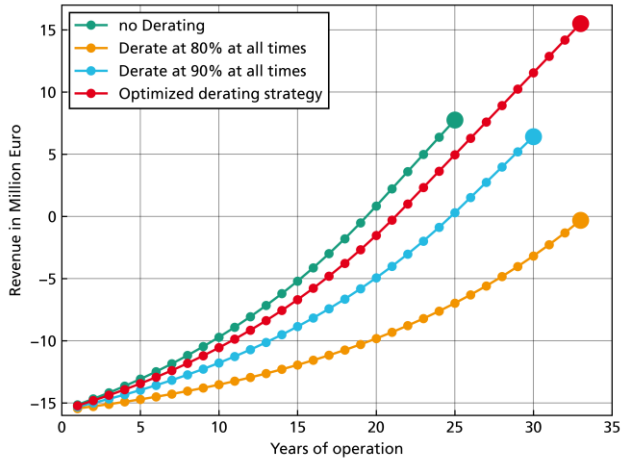
From wind distribution



to planned operation



to planned damage progression



to optimized lifetime, yield and revenue

➔Only the combination of multiple models allows for computation of trade-off between energy and damage

➔Clever planning of operation can yield large increase in lifetime and revenue

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Thanks a lot for your attention!

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