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Condition Monitoring using Digital Twins in tomorrow's Hydropower Plant

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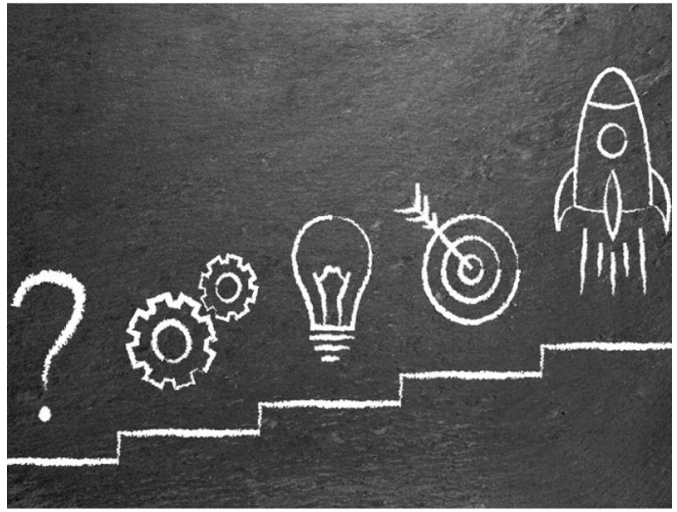
Our Project Approach

DIGITAL TWIN INNOVATION LAB
CADFEM GROUP

Workshop Business Models

- Design Thinking Workshop
- Analysis of existing data and simulation models
- Derive of fast running Business Cases



Prototyping

- Customer specific prototype with preconfigured IoT solution
- Realtime prototype
- Build-up of simulation models
- Implementation of What-If-Scenarios

Implementation

- Integration into customer infrastructure
- Know-how transfer and trainings
- Guided Work – integration of further components

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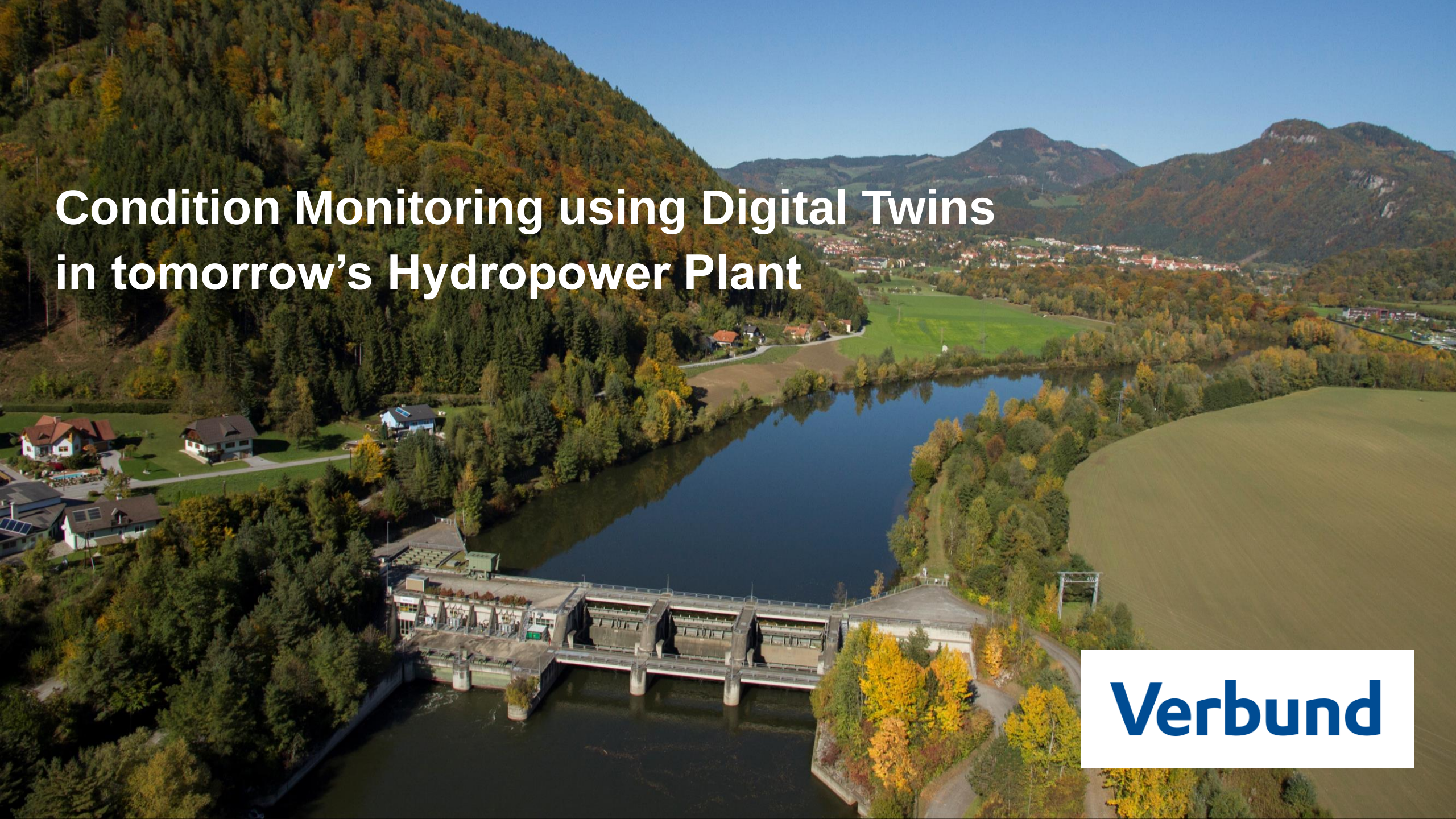
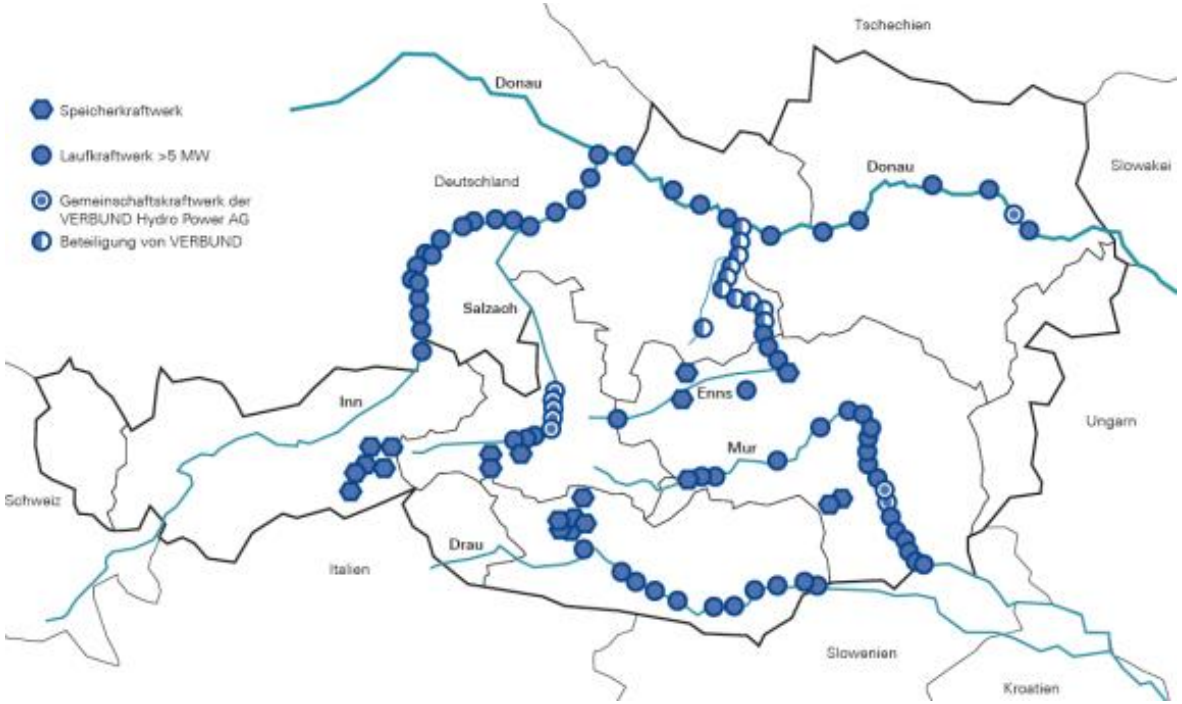


Verbund

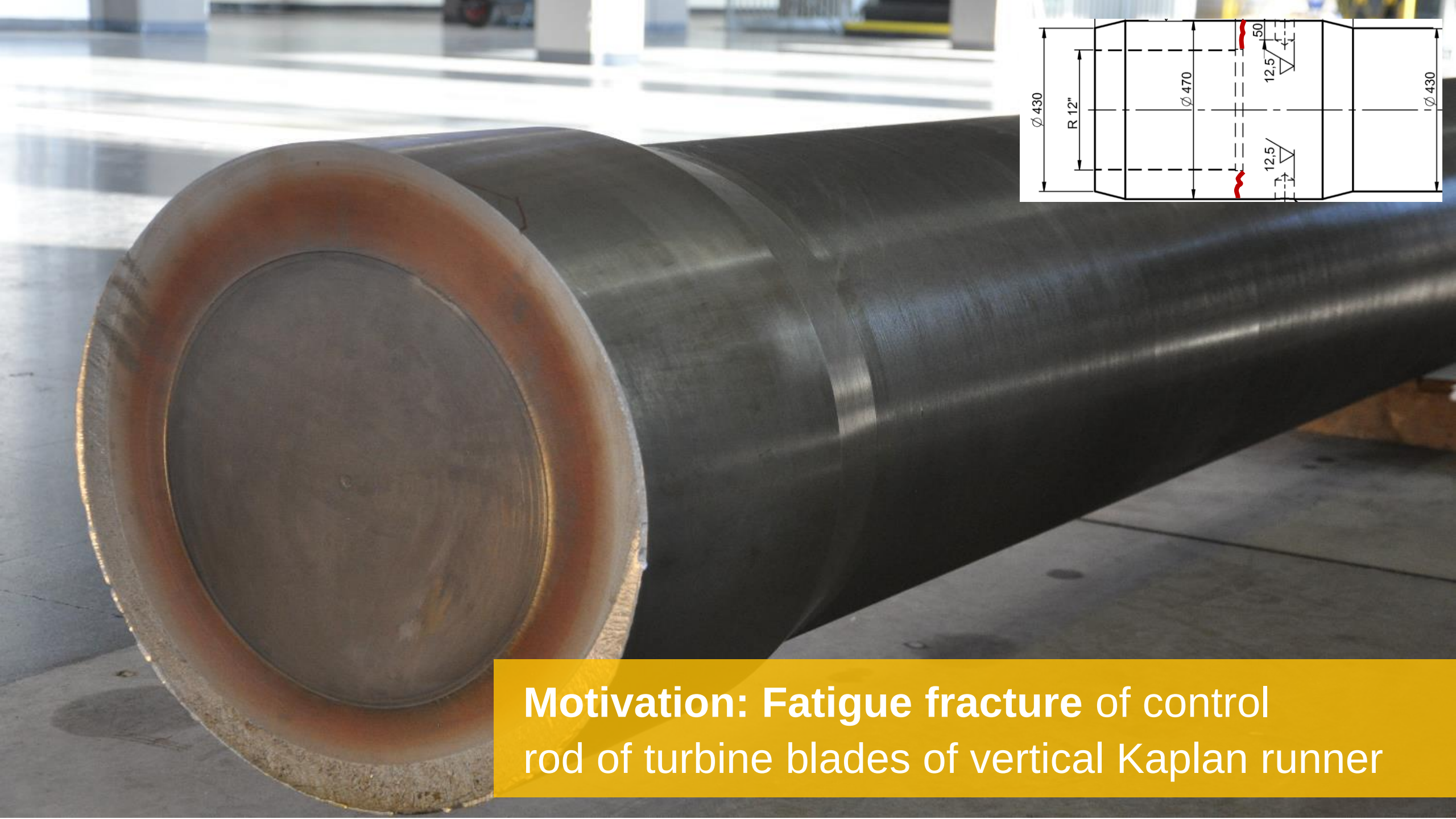
Verbund Hydro Power

- Austria's leading electricity company
- Gain 90% of generation in 128 hydropower plants
- Regulation controlled via 7 central bases



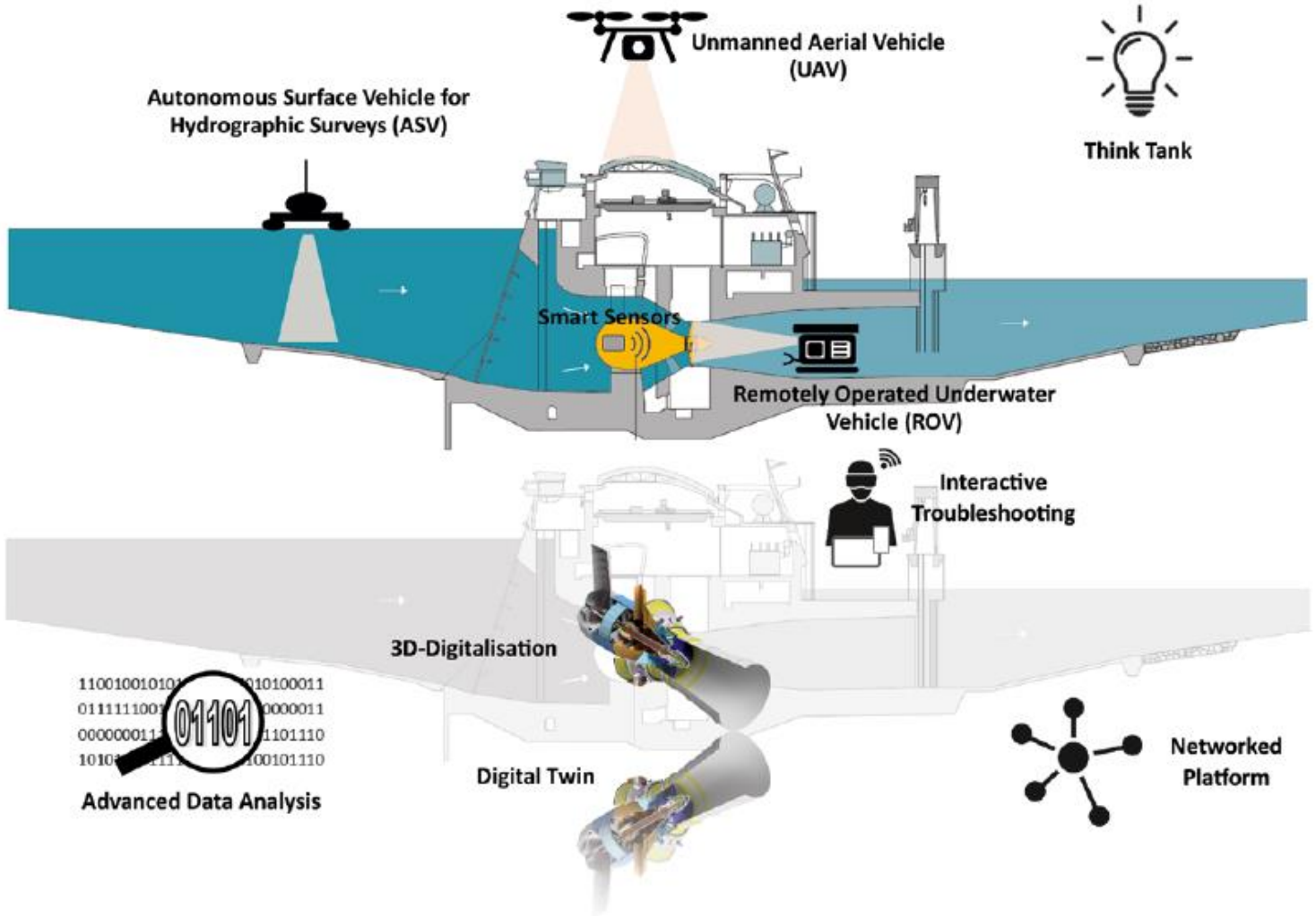
Verbund

Motivation: Fatigue crack at double leaf vertical lift gate of lock chamber



Motivation: Fatigue fracture of control rod of turbine blades of vertical Kaplan runner

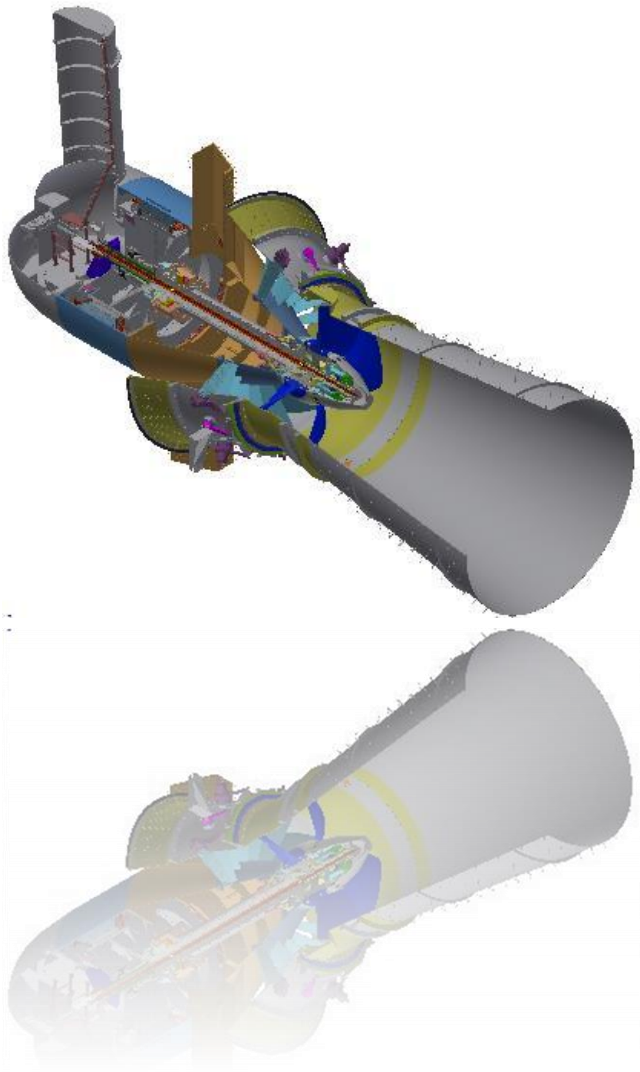
Digital Hydro Power Plant



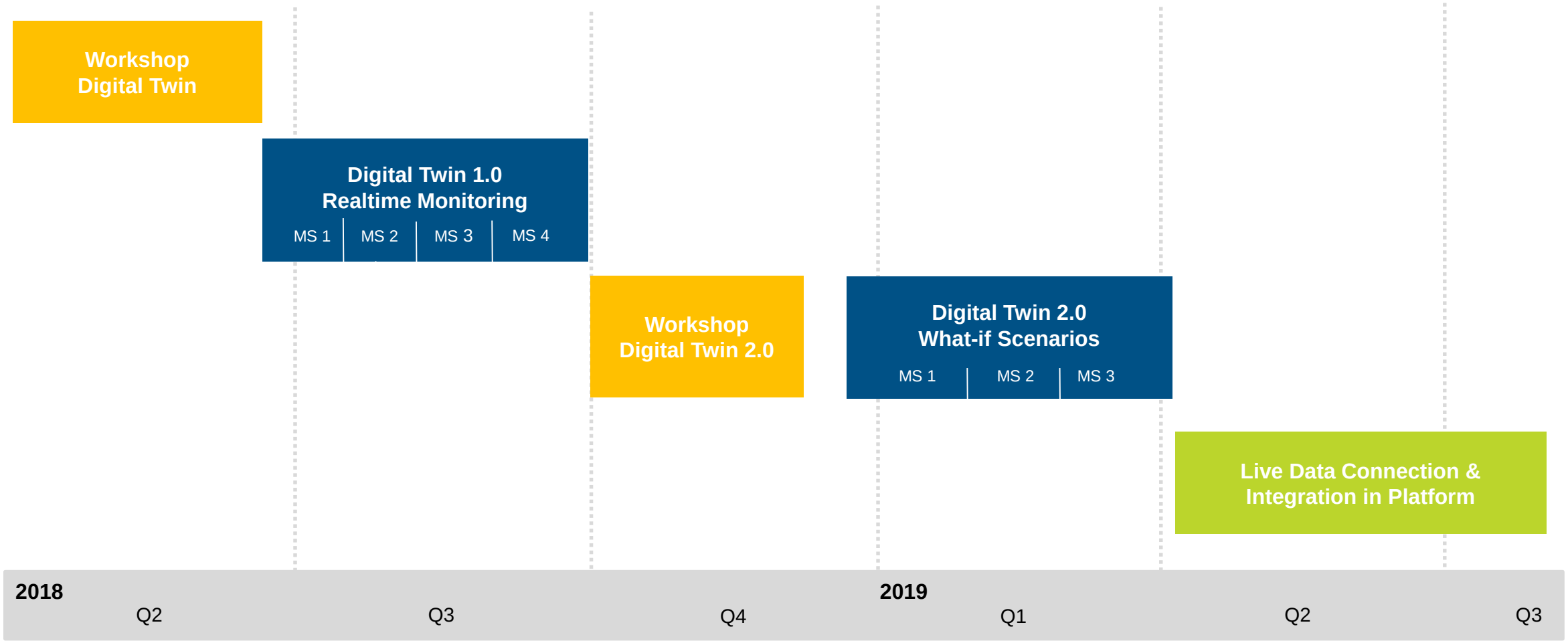
Quelle: Digitales Wasserkraftwerk
VHP I Dr. Hollauf

Definition of a Digital Twin at Verbund

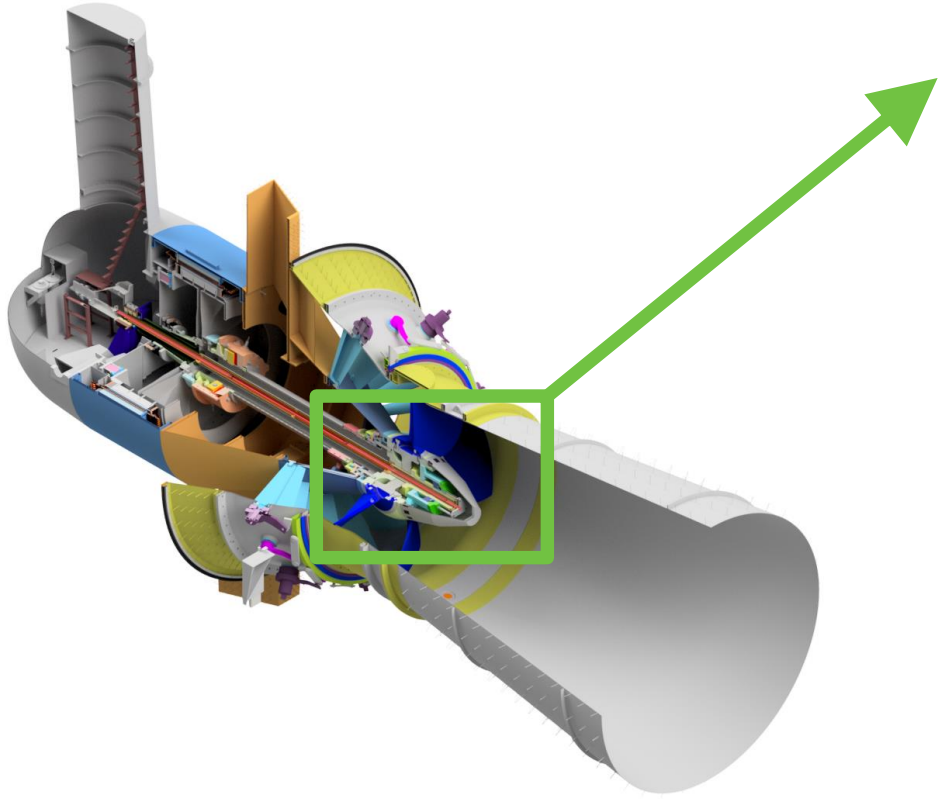
- Simulation-based condition monitoring in real time
- Combination of physical and virtual sensors
- Life time prognosis based on
    a) Measured loads
    b) Synthetic loads
- Predictions and What-if Scenarios

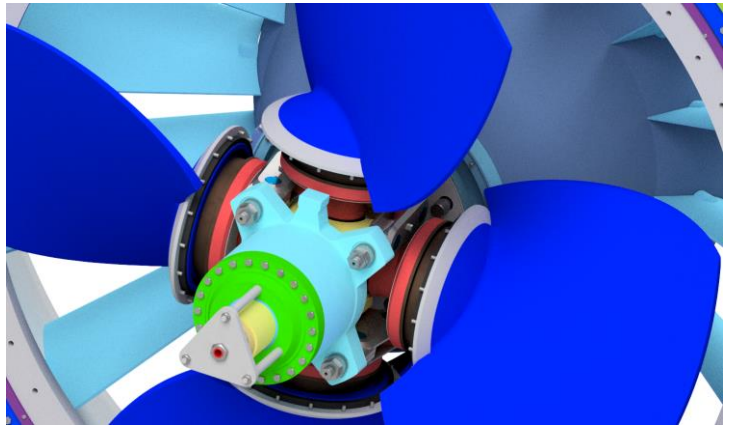


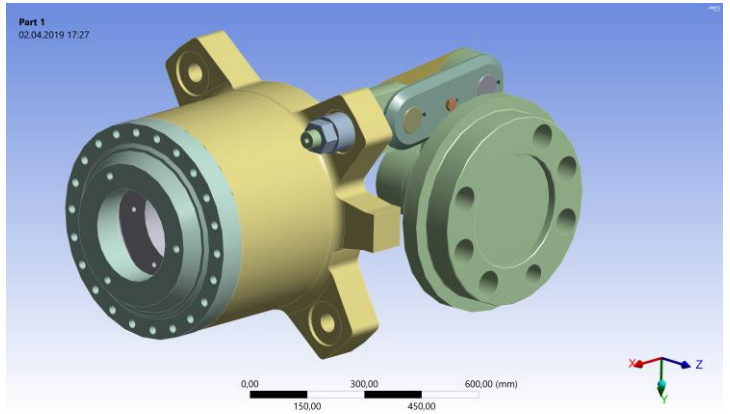
Project Approach

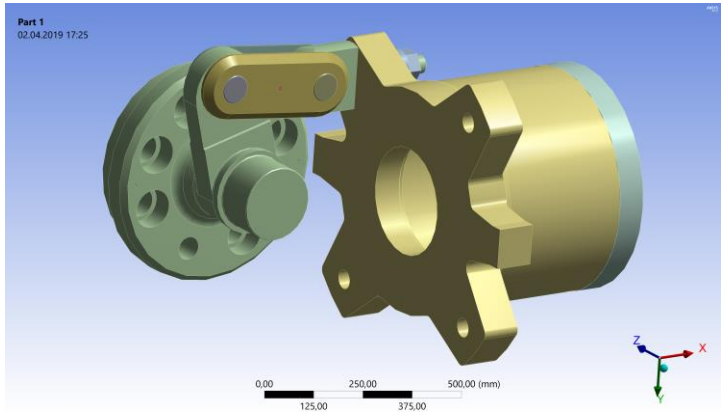


Digital Twin: Selected Component









Motivation

Challenges in the past with control levers of Kaplan runner blades

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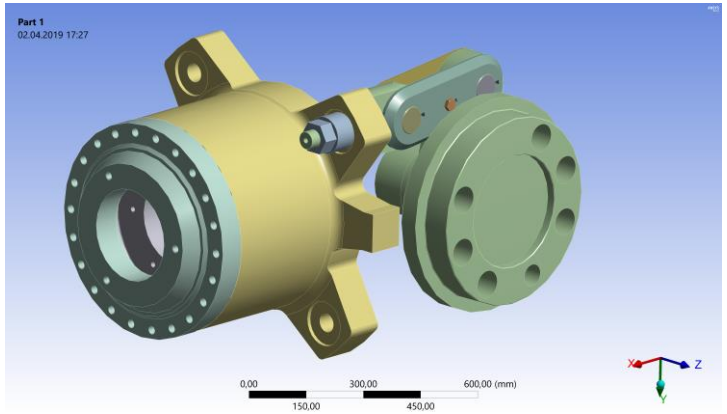
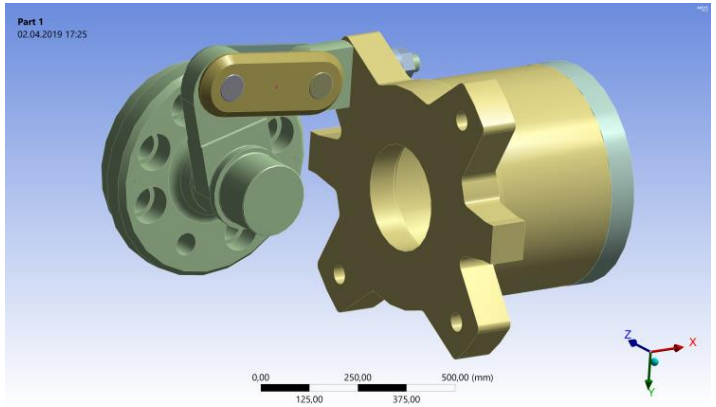
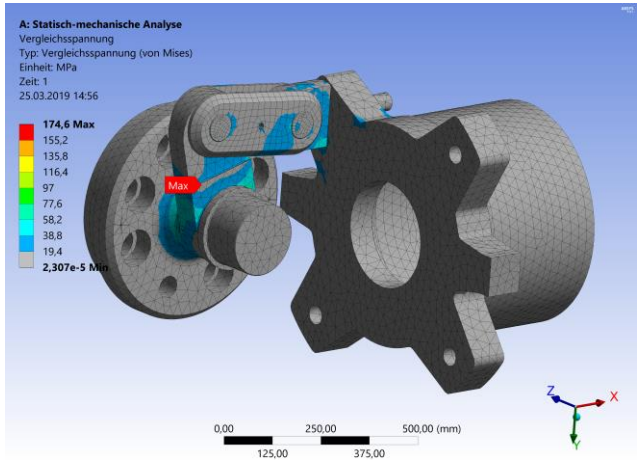
Real-time Monitoring of Remaining Service Life

Digital Twin Generation







3D-Geometry

Finite Element Analysis

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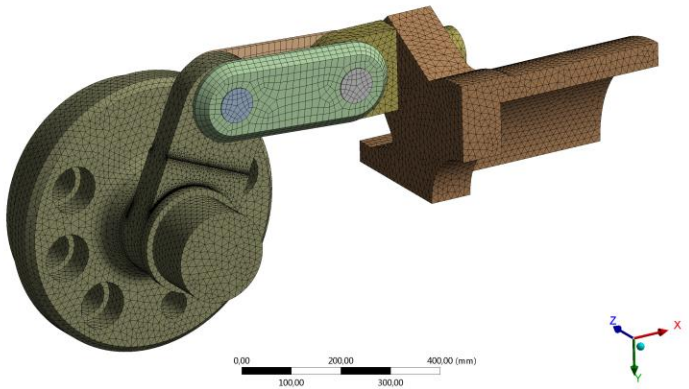
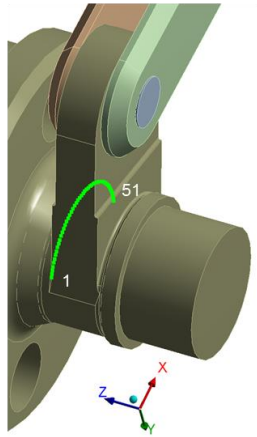
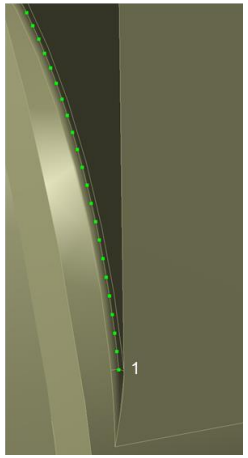
Real-time Monitoring of Remaining Service Life

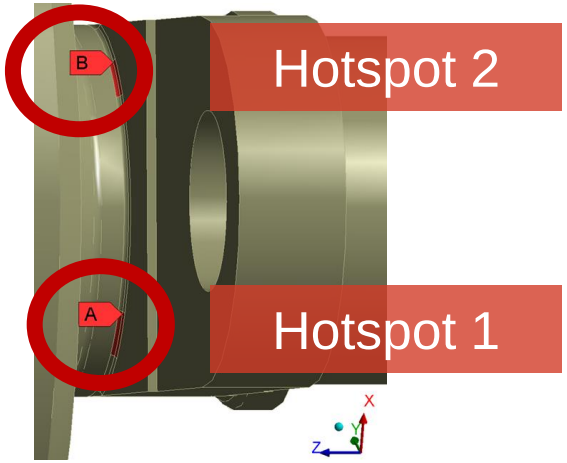
Digital Twin Generation

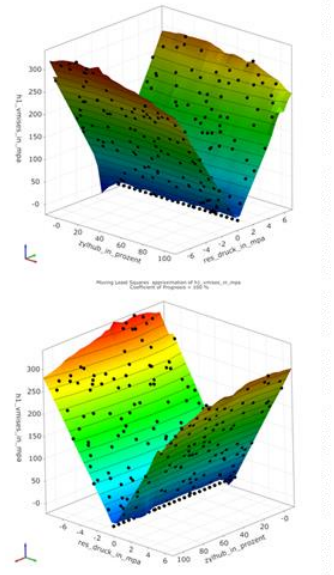
dynardo optiSLang®









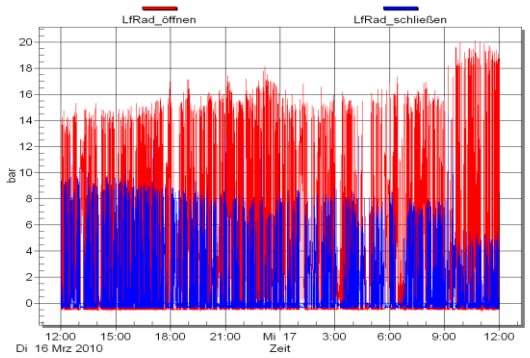


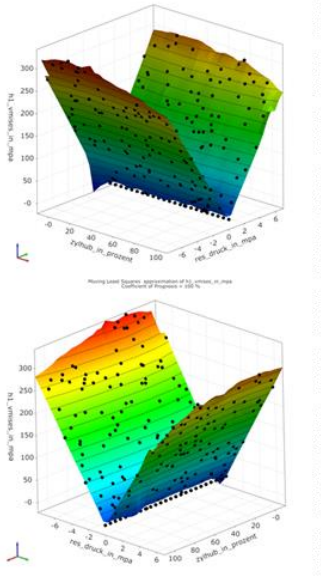
Finite Element Analysis: Determination of the hotspots

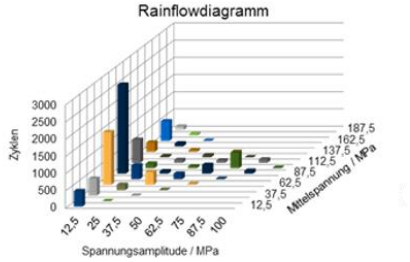
Reduced Order Model (ROM)

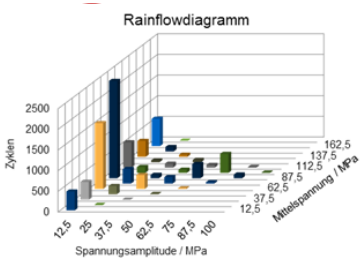
Real-time Monitoring of Remaining Service Life

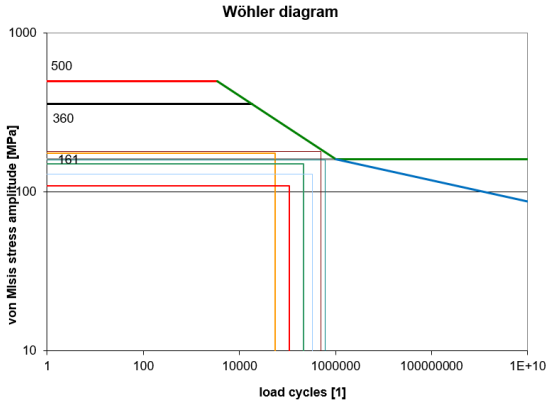
Digital Twin in Operation





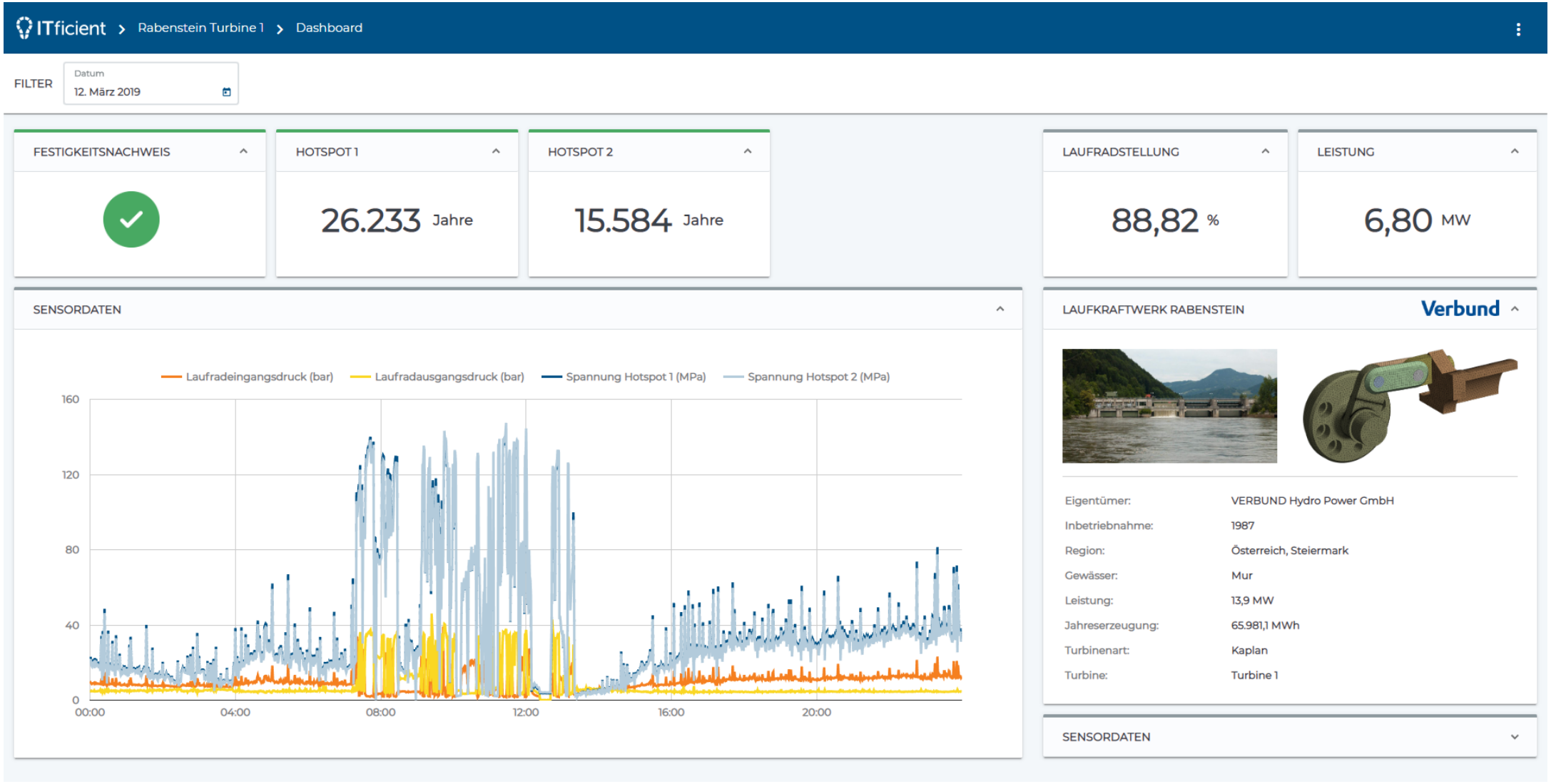






Online measurement data → **ROM** → **Rainflow counting** → **Fatigue analysis**

Demonstration Digital Twin 1.0

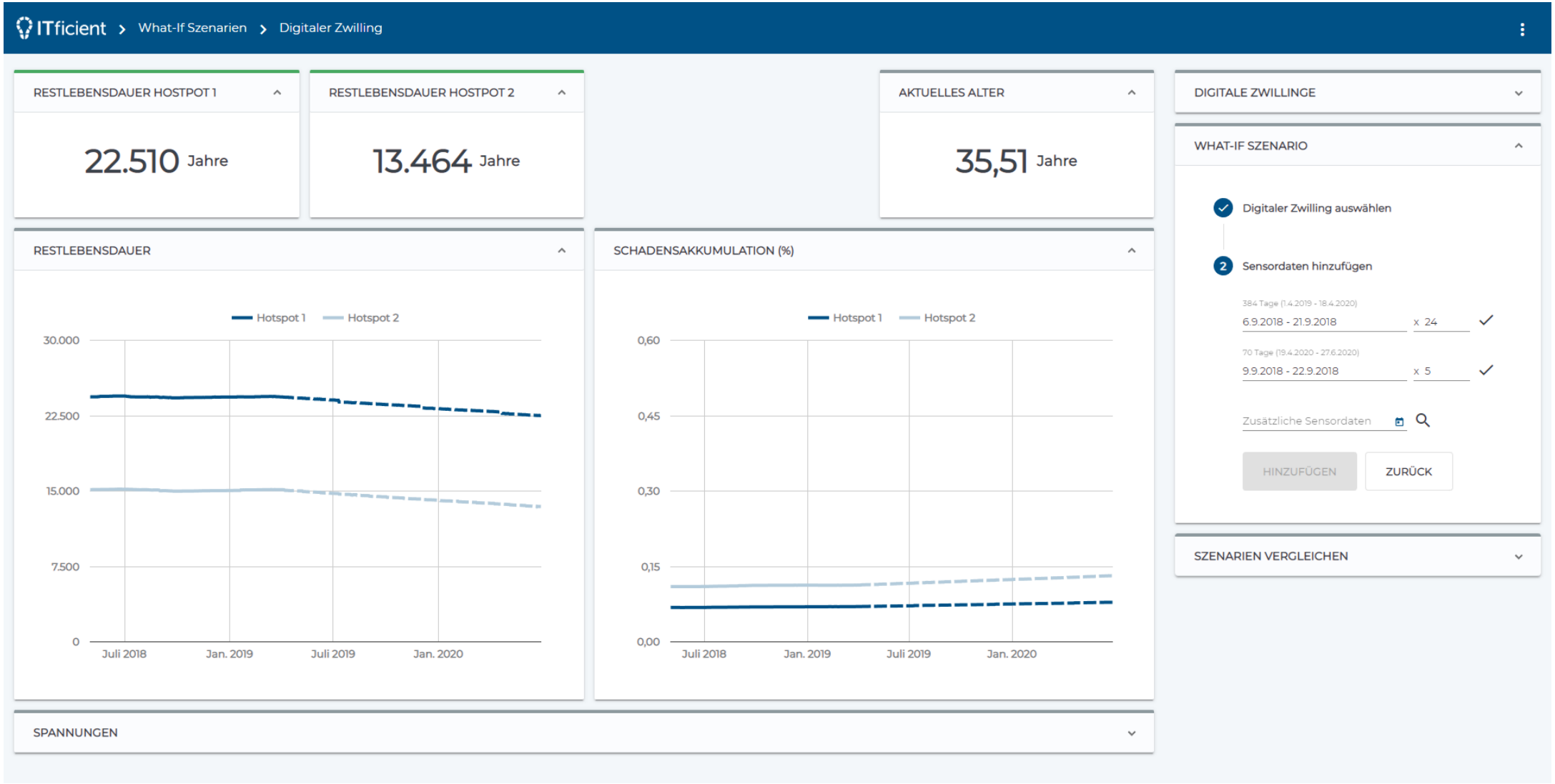


What-if Scenarios

Objectives

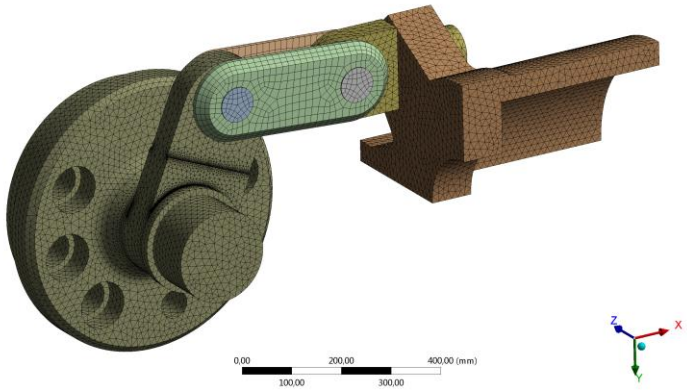
- Provide greater insight into how to operate the system **in a system-friendly way**
- Provide insights what it means for the **lifetime** if the system is operated under **very high or low loads** (synthetic load spectrum)

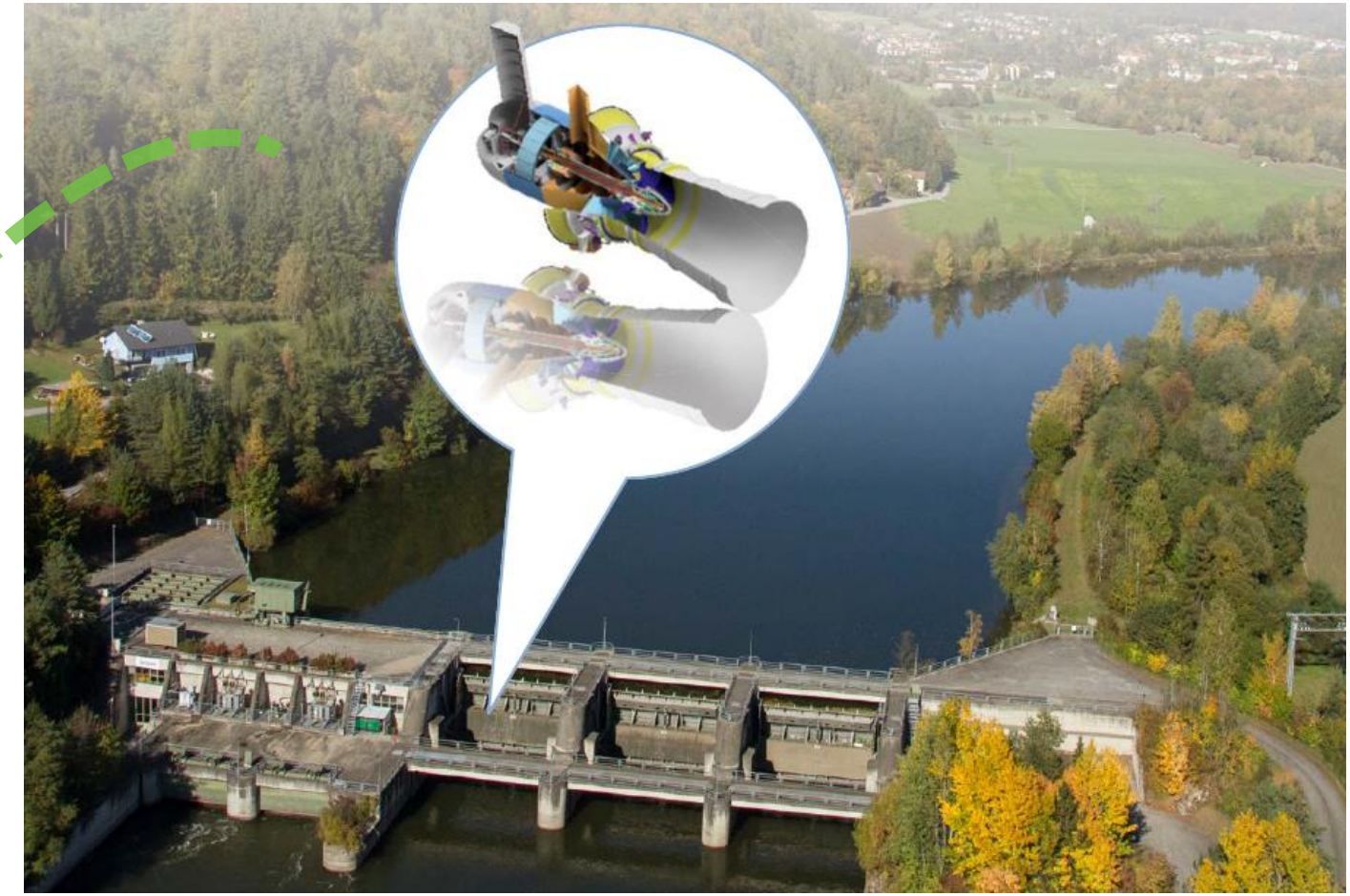
Demonstration Digital Twin 2.0



Outlook: Next Steps

From one component back to the whole picture…





Advantages & Opportunities

- Real time monitoring and fatigue analysis
- Analysis of different operating conditions
- Preventive revision intervals

Challenges

- Geometrical data of component
- Historical load collectives and material properties of component
- Implementation into networked platform

Benefits for VERBUND

"In addition to achieving the highest possible **availability** of hydropower plants, we also aim to get a more well-founded forecast of their remaining service lives. We also expect benefits in terms of the **condition-based servicing** and the avoidance of expensive repairs."

Dipl.-Ing. Dr. Bernd Hollauf
Projektleiter „Digitales Wasserkraftwerk“ bei der Hydro Power GmbH

„This process of asking ‘what if X happens’ can provide us with greater **insight into how to operate the system** in a system-friendly way or what it means for the service life if the system is operated under very high loads.”

Dipl.-Ing. Michael Artmann
Projektleiter „Digitaler Zwilling“ bei der Hydro Power GmbH

Business and Service Models – Discussion

Optimal Operation

Optimal operation

- Secured availability
  - Condition based monitoring
  - Cost reduction by optimized service and spare parts
- Balancing of operation time, performance & operation costs

Smart Products / Services

New revenue streams

- New business models
  - Maintenance as a Service
  - Recommendations as a Service
  - Machine as a Service
- Customer specific solution sales
  - Configure price quote (CPQ)

Customer loyalty

- Competitive positioning
- Customer satisfaction
- Trust
- Innovation power

Contact Information

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