



# Tidal turbines Reliability And Condition Monitoring

21/10/2020







# GENERAL PRESENTATION



OUR CORE TECHNOLOGY

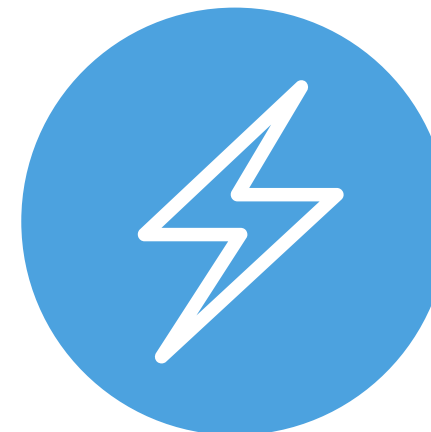
## A UNIQUE TURBINE CONCEPT



### Two vertical, counter-rotating columns

Reliable in harsh conditions

Performant in turbulent flows



### Suitable for a range of applications

Adaptable in size and power output



### Reaching competitiveness

Strictly following the learning curve & LCOE evolution of wind turbine technologies

HydroQuest is a leading technology provider thanks to superior field performance

10 YEARS OF TECHNOLOGY DEVELOPMENT

## MILESTONES



TIDAL POWER – A 100GW MARKET

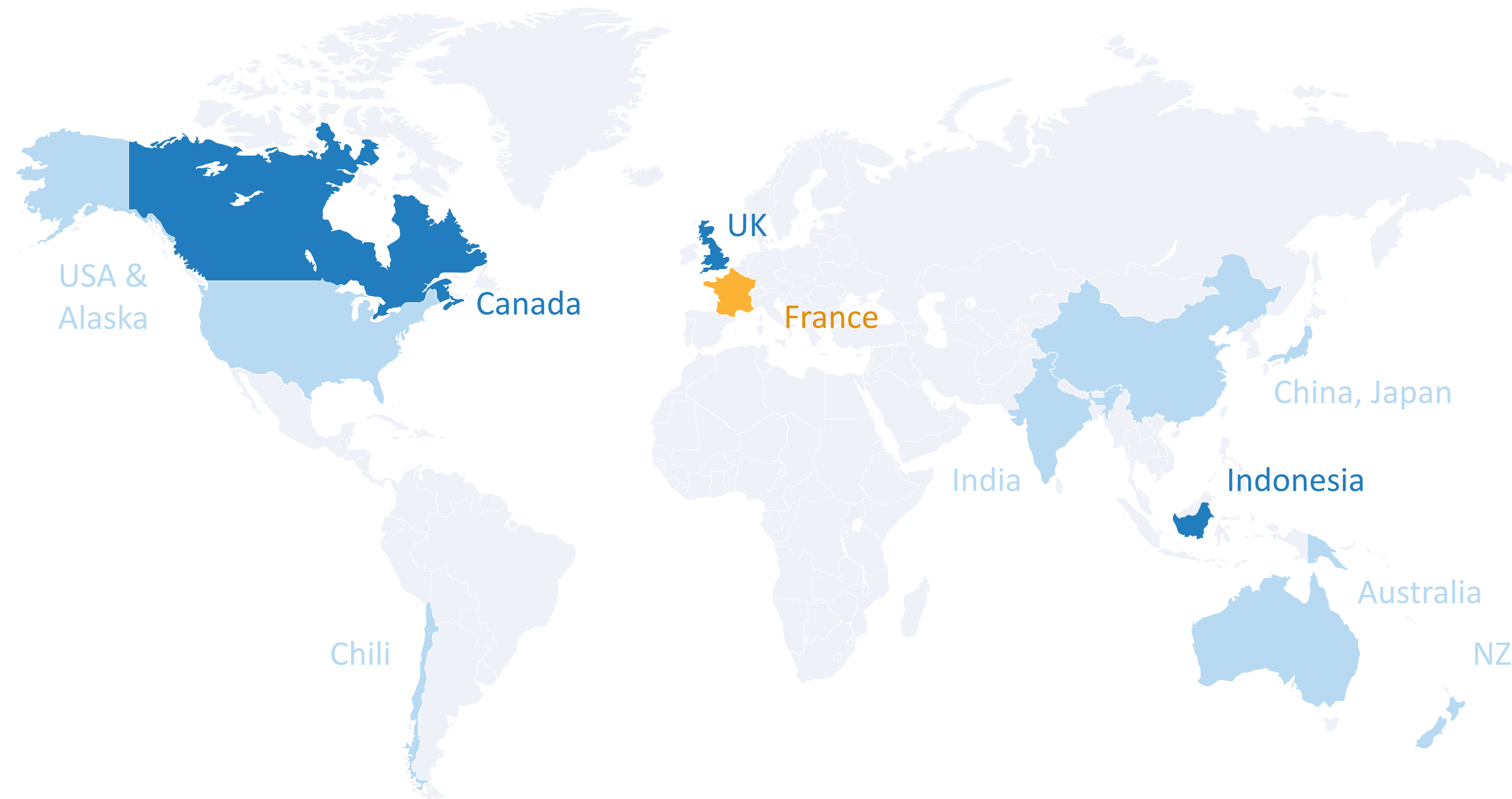
# FRANCE FIRST, WORLD SECOND

▶ **Step 1 – France**  
3 sites - 3.5GW (equ. 15bn€)

▶ **Step 2 – Replicating success with Canada, UK, Indonesia**  
Once first French site signed.  
Opening 12GW (equ. 50bn€)

▶ **Step 3 – Diffusing technology**  
Smaller sites, 20GW (equ. 100bn€)

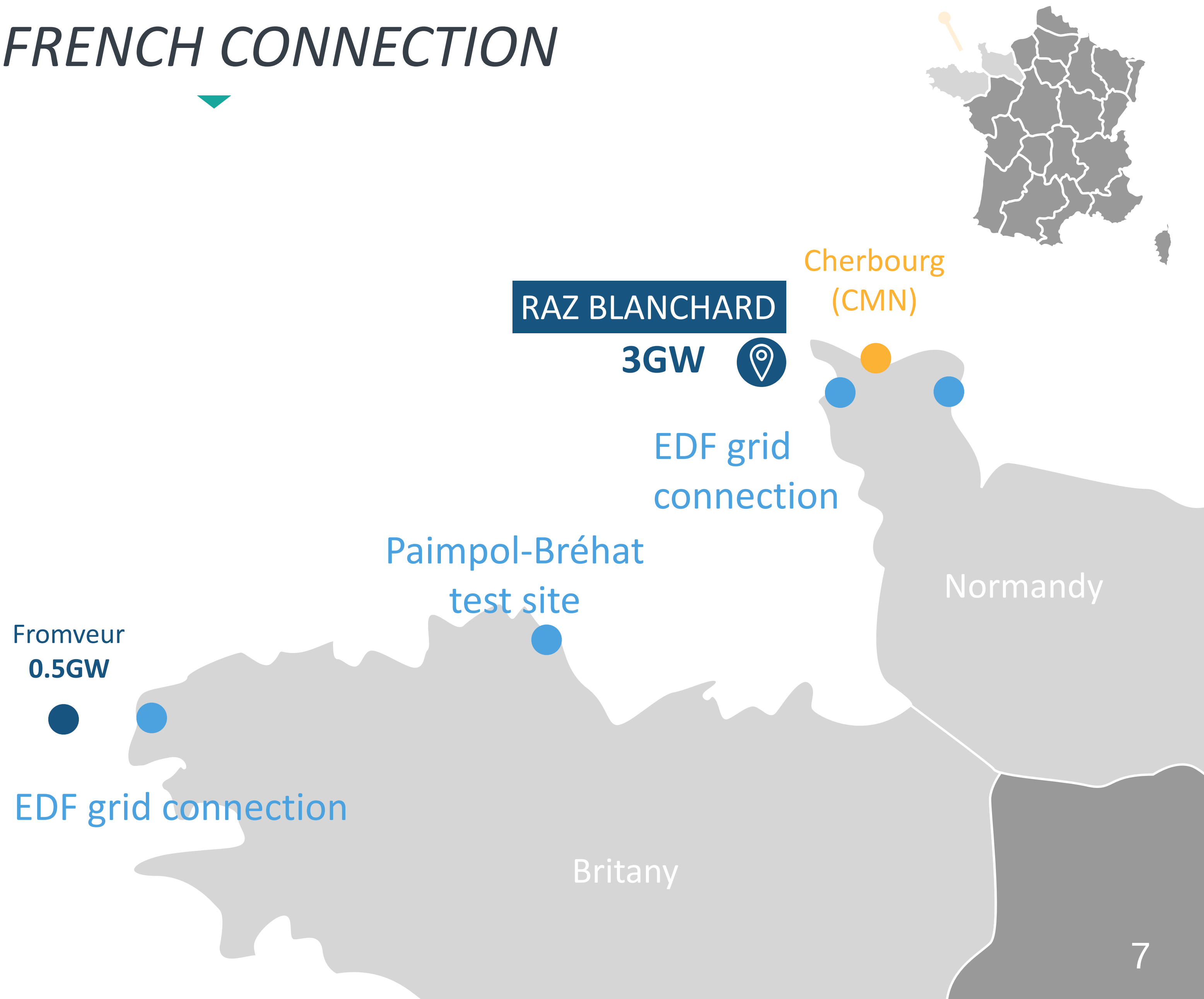
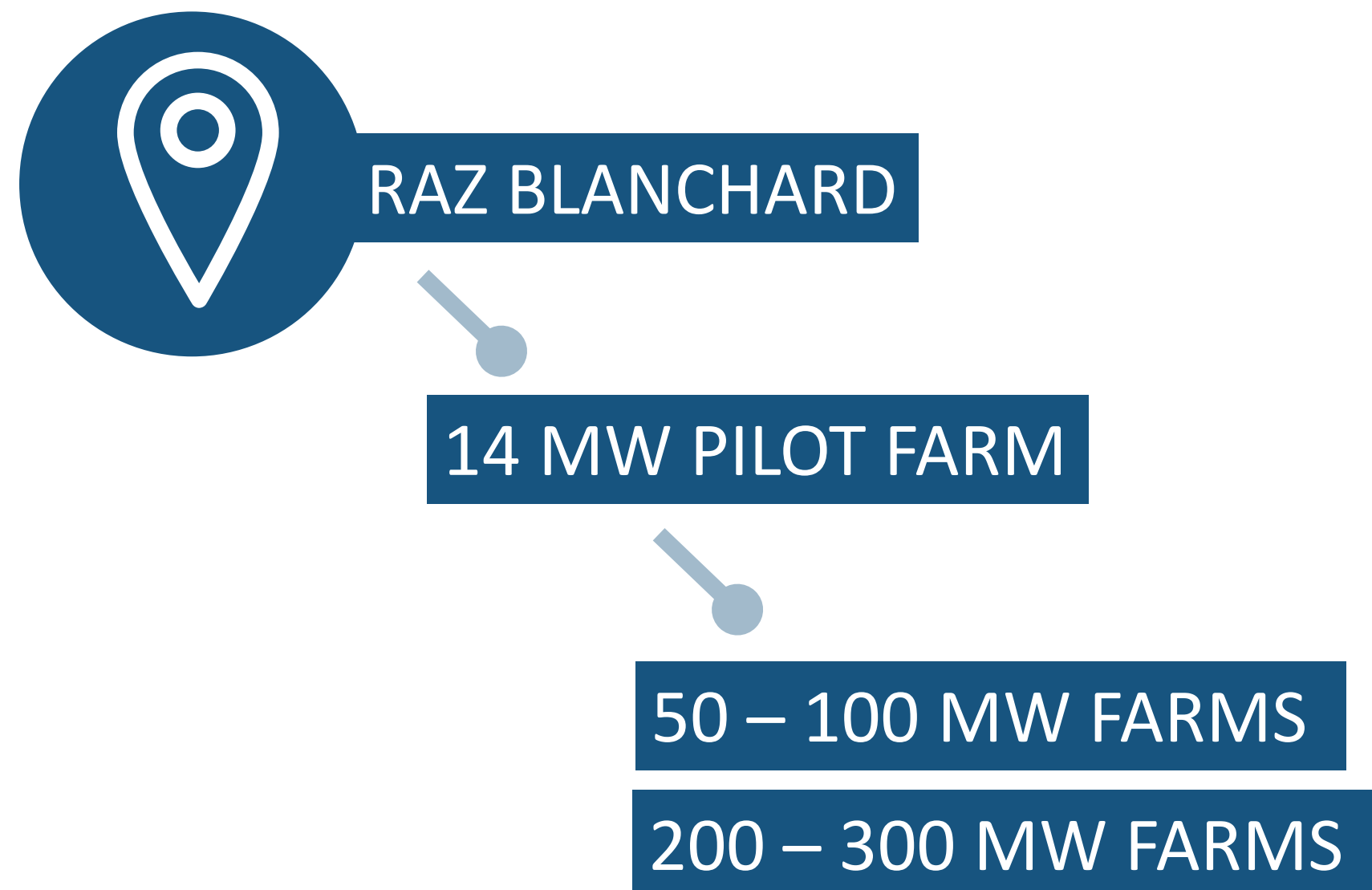
▶ **Step 4 - Rest of the world**  
60+ GW





# THE *FRENCH CONNECTION*

- ▶ **2 sites = equivalent to 2 nuclear plants**  
Generating power night & day
- ▶ **Easy connection to the grid**  
Reduced deployment costs
- ▶ **Local high tier industry partner**  
With proven track record & easy access to sites





## ► The CMN partnership

- CMN: French leading shipbuilder (civil & military)
- Decades of industrial manufacturing expertise
- Adequate production capabilities
- Located in Cherbourg – facing Raz Blanchard
- Industrial partnership, especially for Raz Blanchard deployment (30 km)



## ► Local supply chain specific features

- To reduce costs, final assembly always to be performed as close as possible to tidal sites
- Manufacture close to quay side, able to receive Offshore Construction Vessel
- Adequate production capabilities





**1MW prototype project**



 Turbine description

1

**OceanQuest 1 turbines**

4 rotors of 8 m diameter x 4 m high

1 MW

**Nominal output power / unit**

280 T

**Dry weight**

Overall dimension of 24 m long x 12 m high

20 month

**Total fabrication duration**

6 month for final assembly in CMN workshop

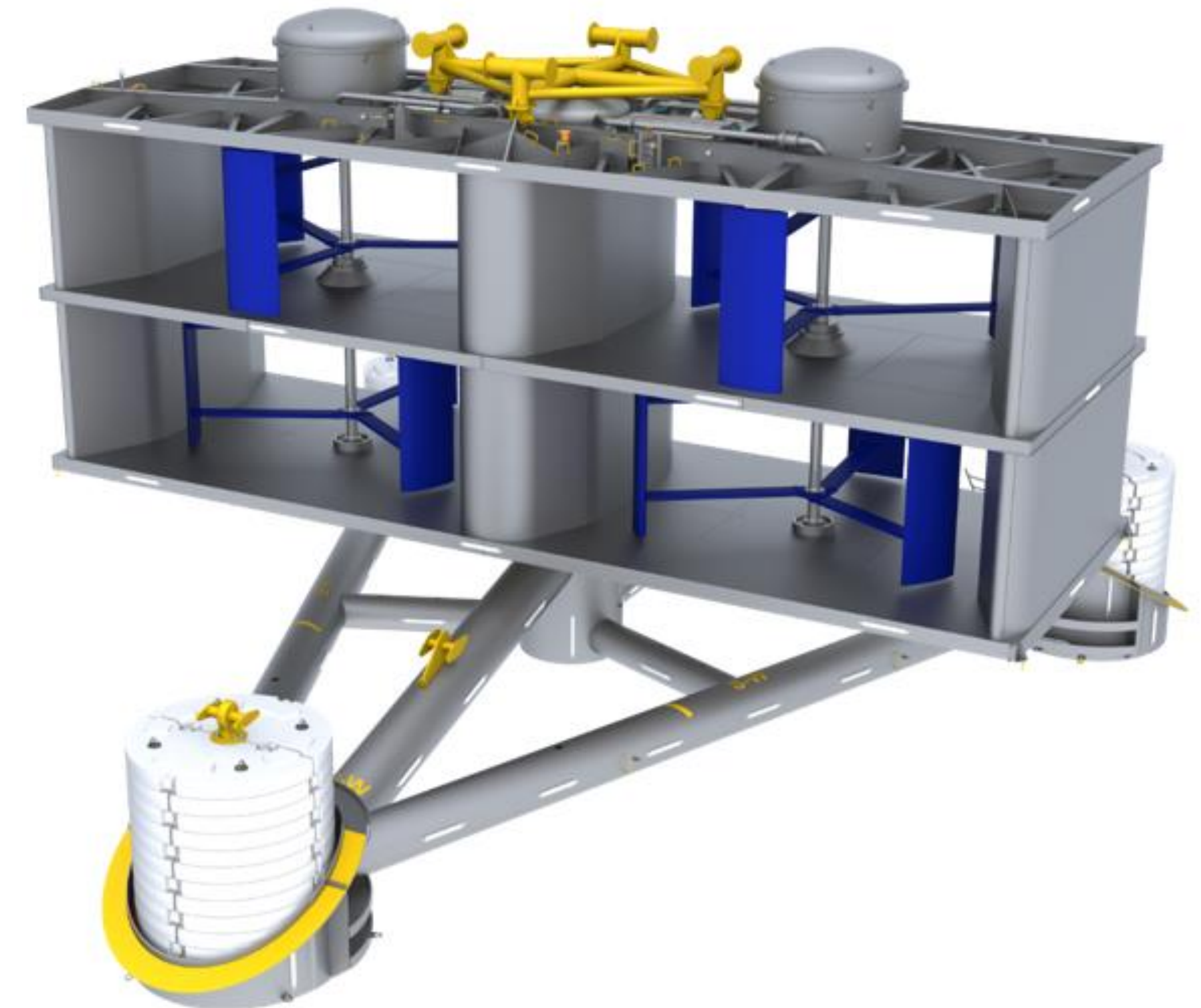
 Foundation description

250 T

**Foundation Dry weight**

Overall dimension of 28 m x 24 m

1000 T

**Cast iron Ballast Dry weight**



► Installation

**April  
2019**

Foundation, ballast, turbine

**DP 400T**

Normand Vision  
4 days of operation

► Operation

**91%**

Availability

**IEC 62600**

Power curve certified by Bureau  
Veritas

**2021**

Decomissioning and inspection  
After 2 years of operation

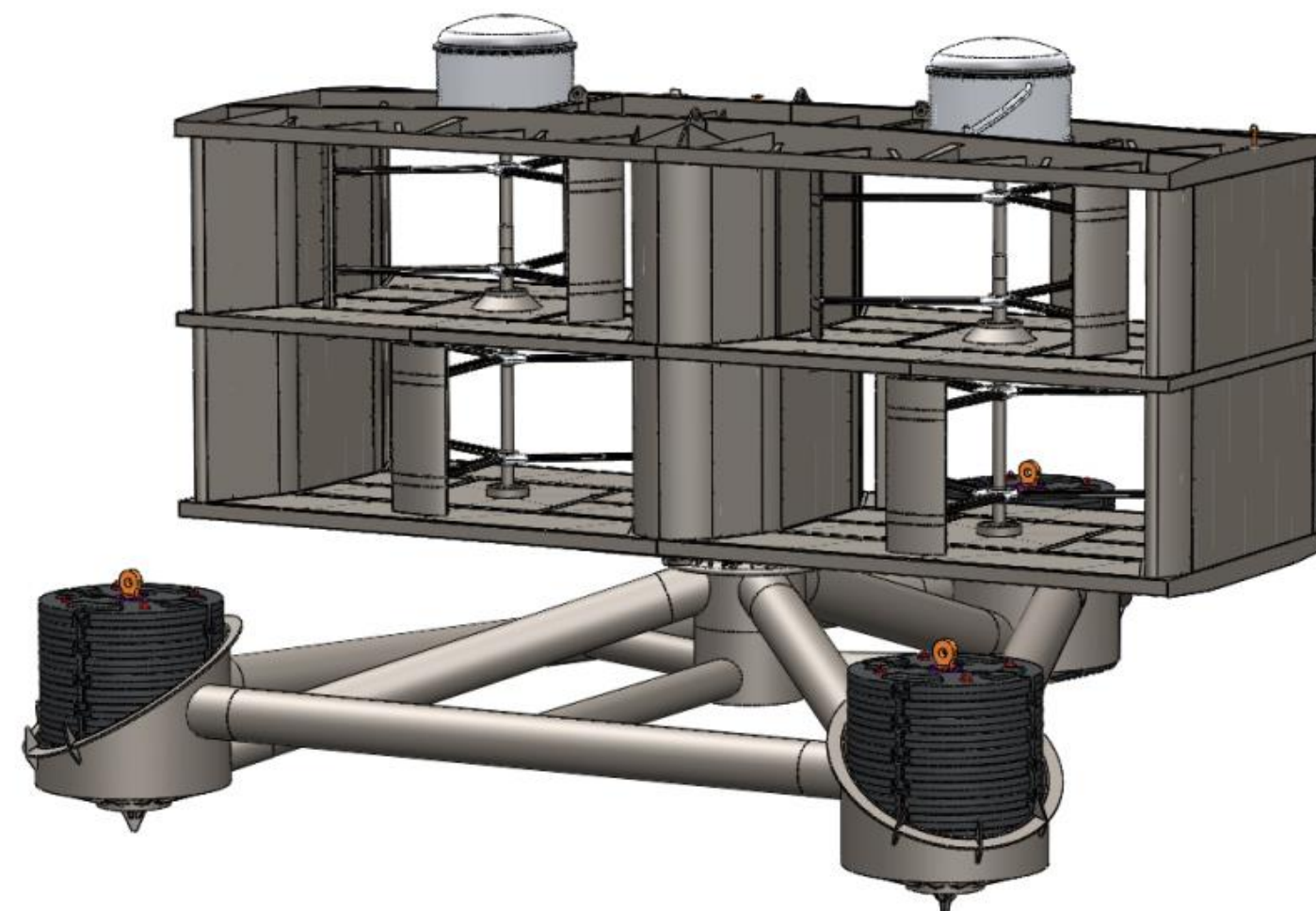
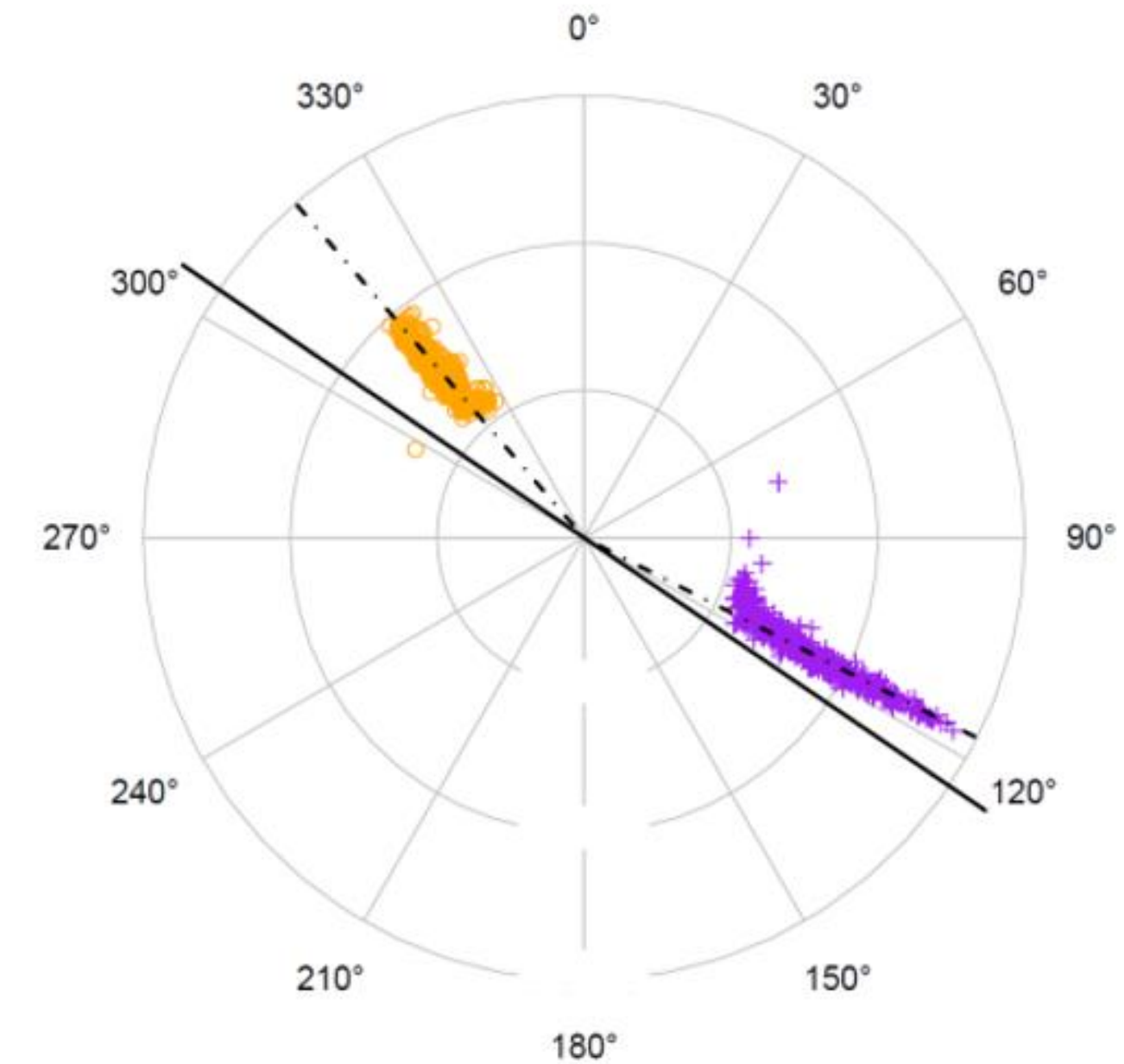




# A RELIABLE CONCEPT

## ► Reliability by Concept

- Yaw-less pitch-less concept
- Only moving / active parts is the drive train
- Steady performance on wide incidence range
- Immune to high turbulence in flows
- Industry standards drive train components





# APPROACH TO RELIABILITY



## ► Project Objectives

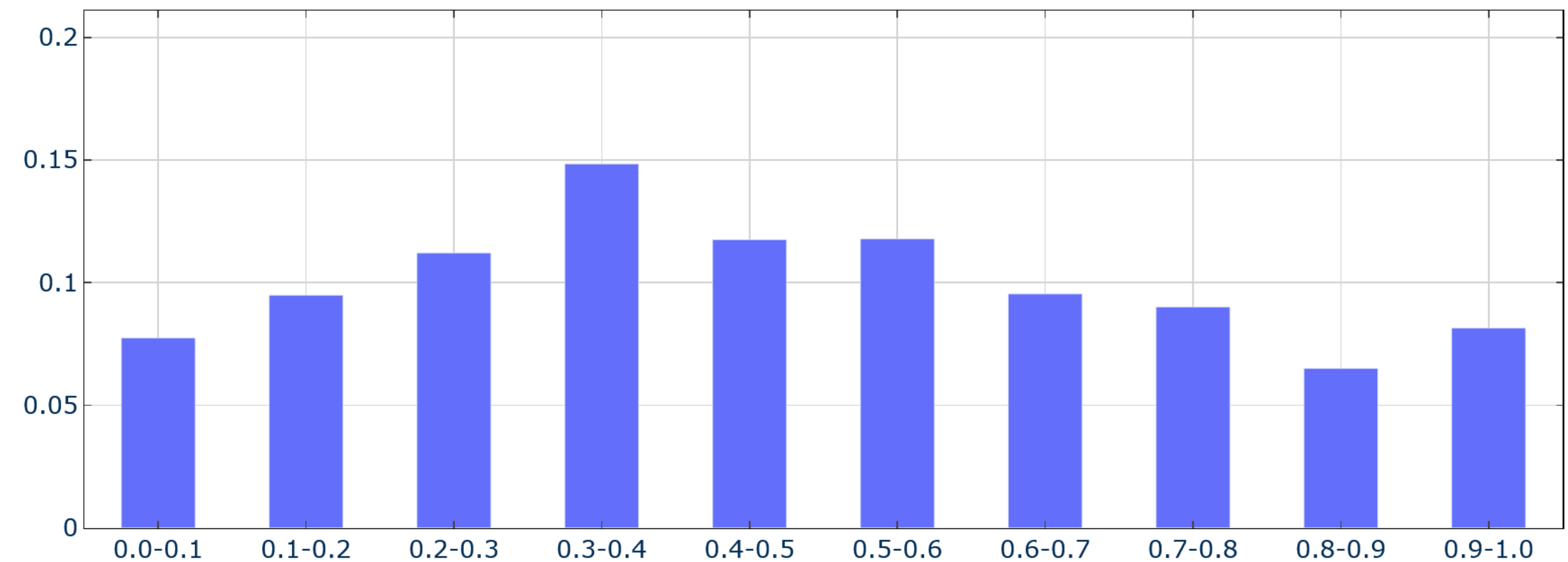
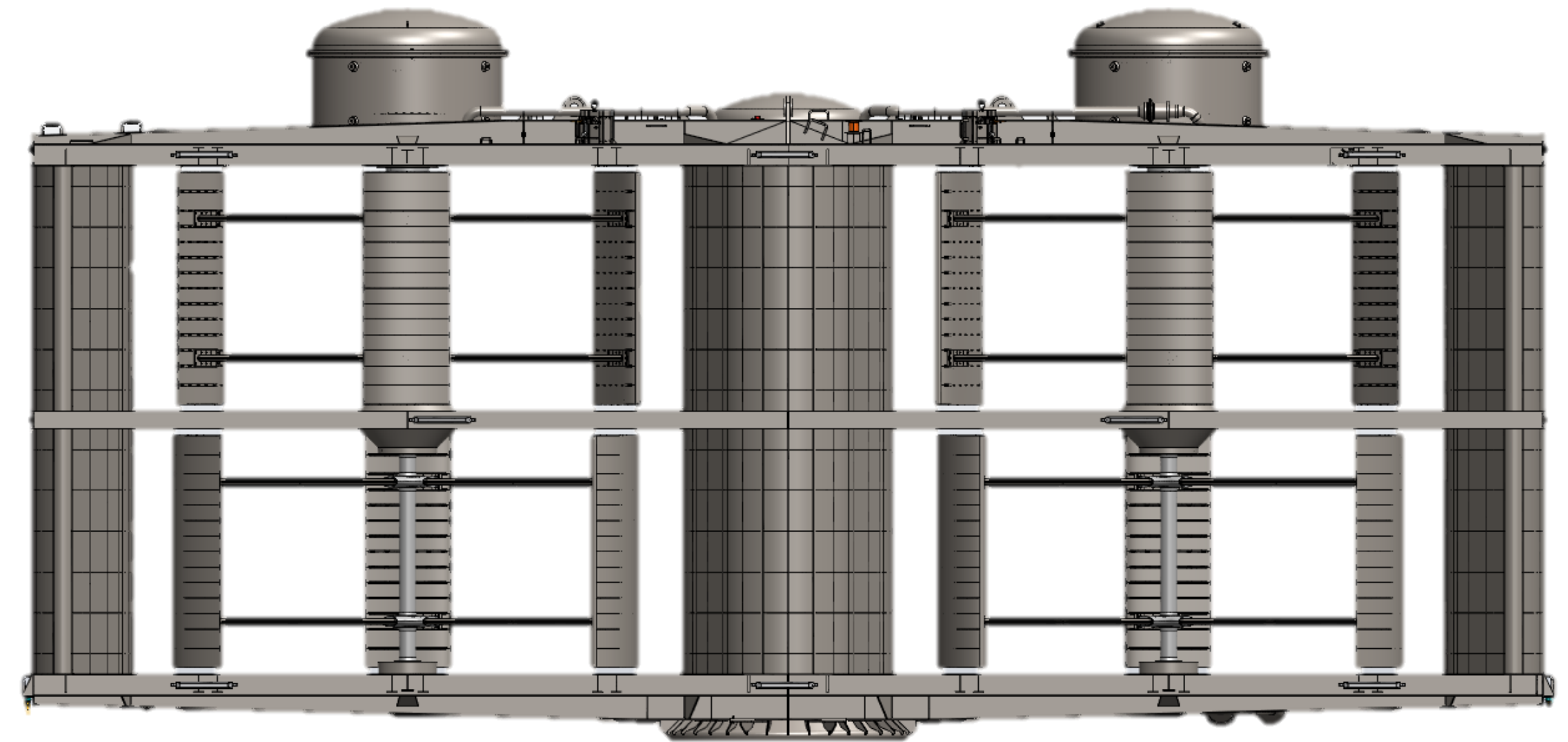
- Continuous operation during test period
- Real condition proofing of reliability strategy
- Improve knowledge base on operation conditions

## ► Implementation

- Reliability by design philosophy
- Comprehensive condition monitoring system



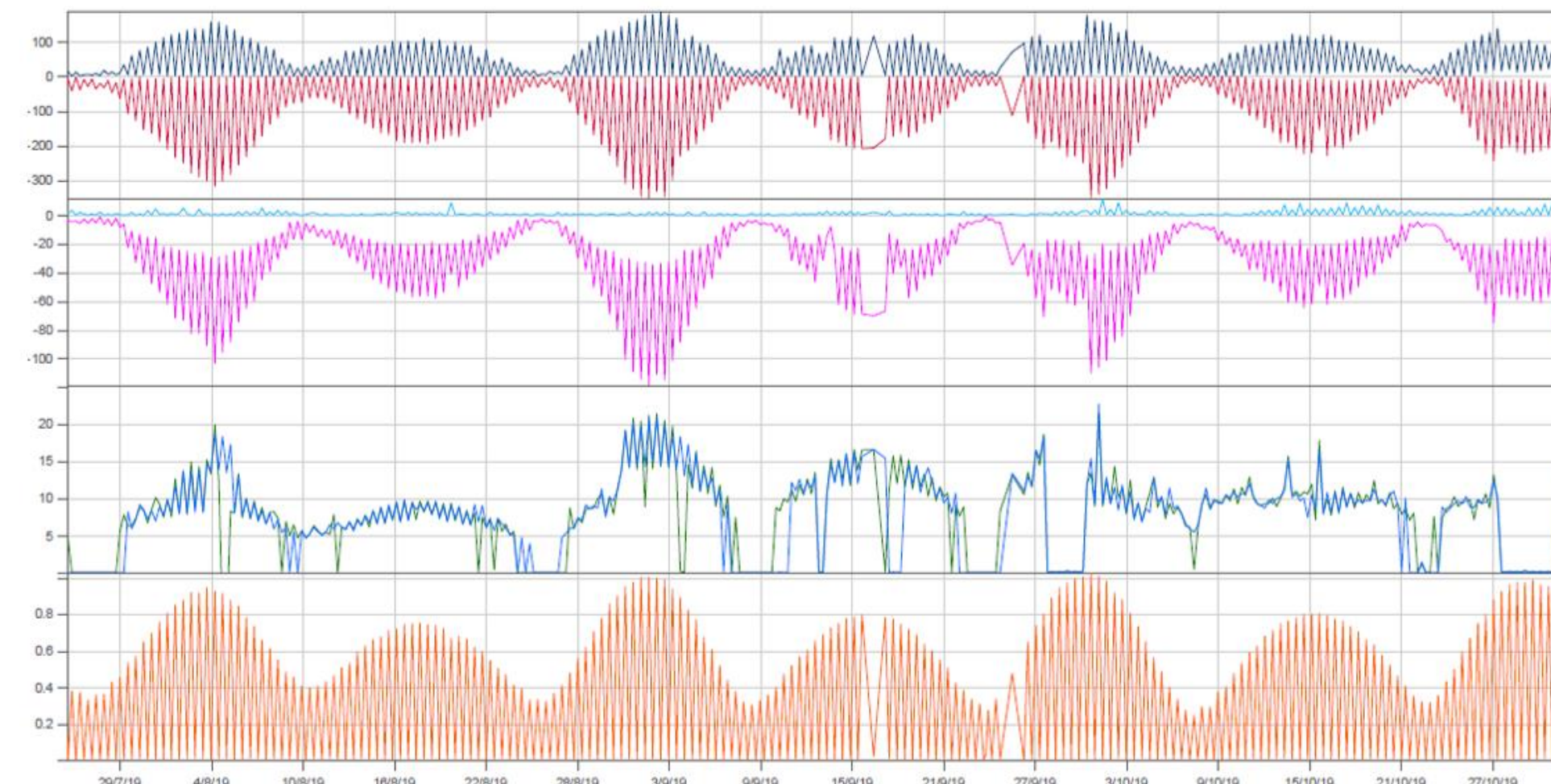
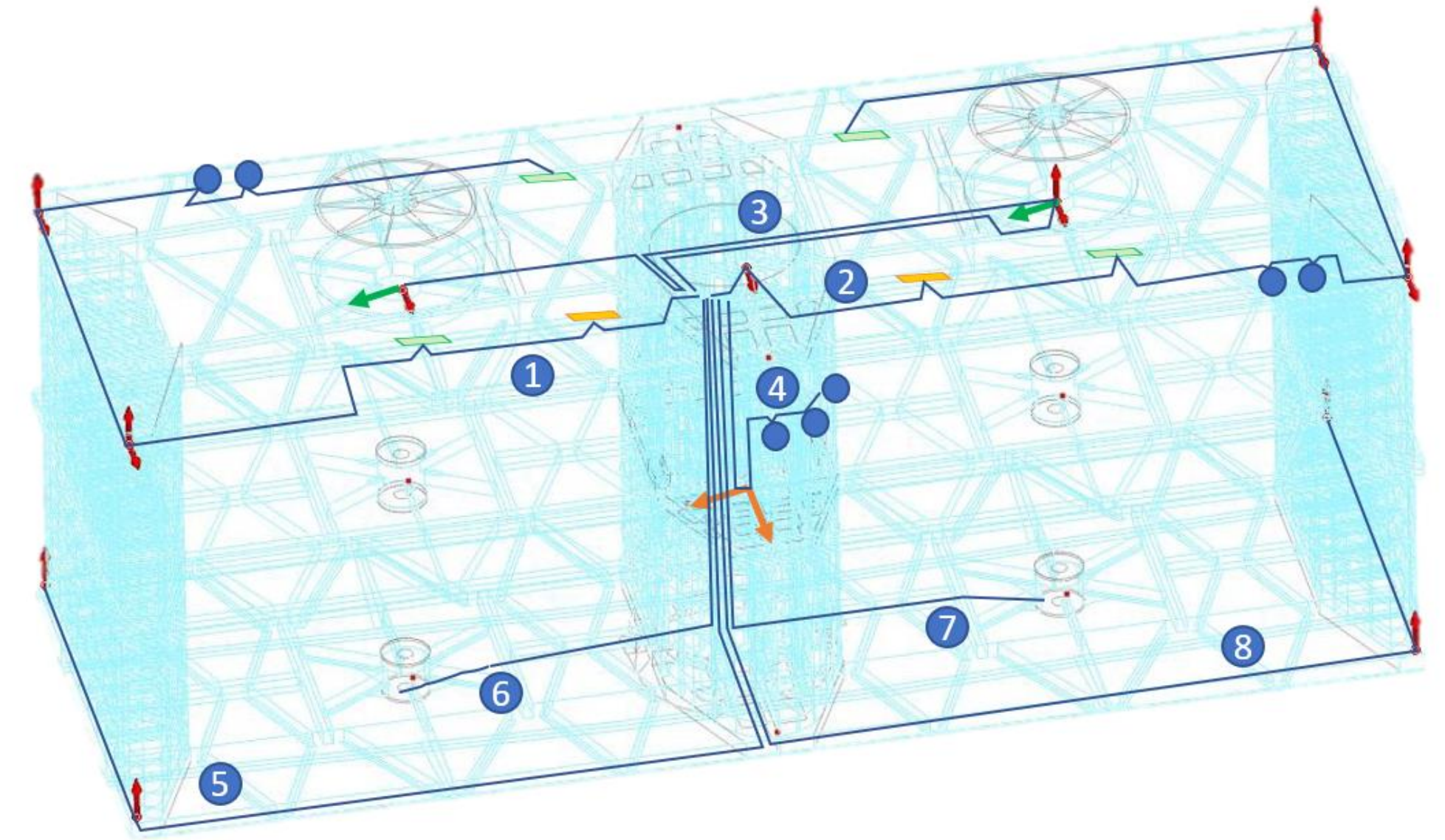
- ▶ **Make the most of the native redundancy**
- ▶ **MTBF Analysis**
- ▶ **Definition of N-1 and N-2 criterias**
- ▶ **Integration in statistic energy production calculations**





# CONDITION MONITORING

- ▶ **Vibrations**
- ▶ **Loads**
- ▶ **Ambient Temperatures and Temp rise in power system elements**
- ▶ **Linked with sea state and current speed**







**New generation : OceanQuest 2.5**



### Turbine description

1

**OceanQuest 2.5 turbine**

4 rotors of 8 m diameter x 6 m high

2,5 MW

**Nominal output power / unit**

At rated speed of 3,7 m/s

200 T

**Dry weight**

Overall dimension of 21 m long x 16 m high

15 month

**Total fabrication duration**

3 month for final assembly

### Foundation description

250 T

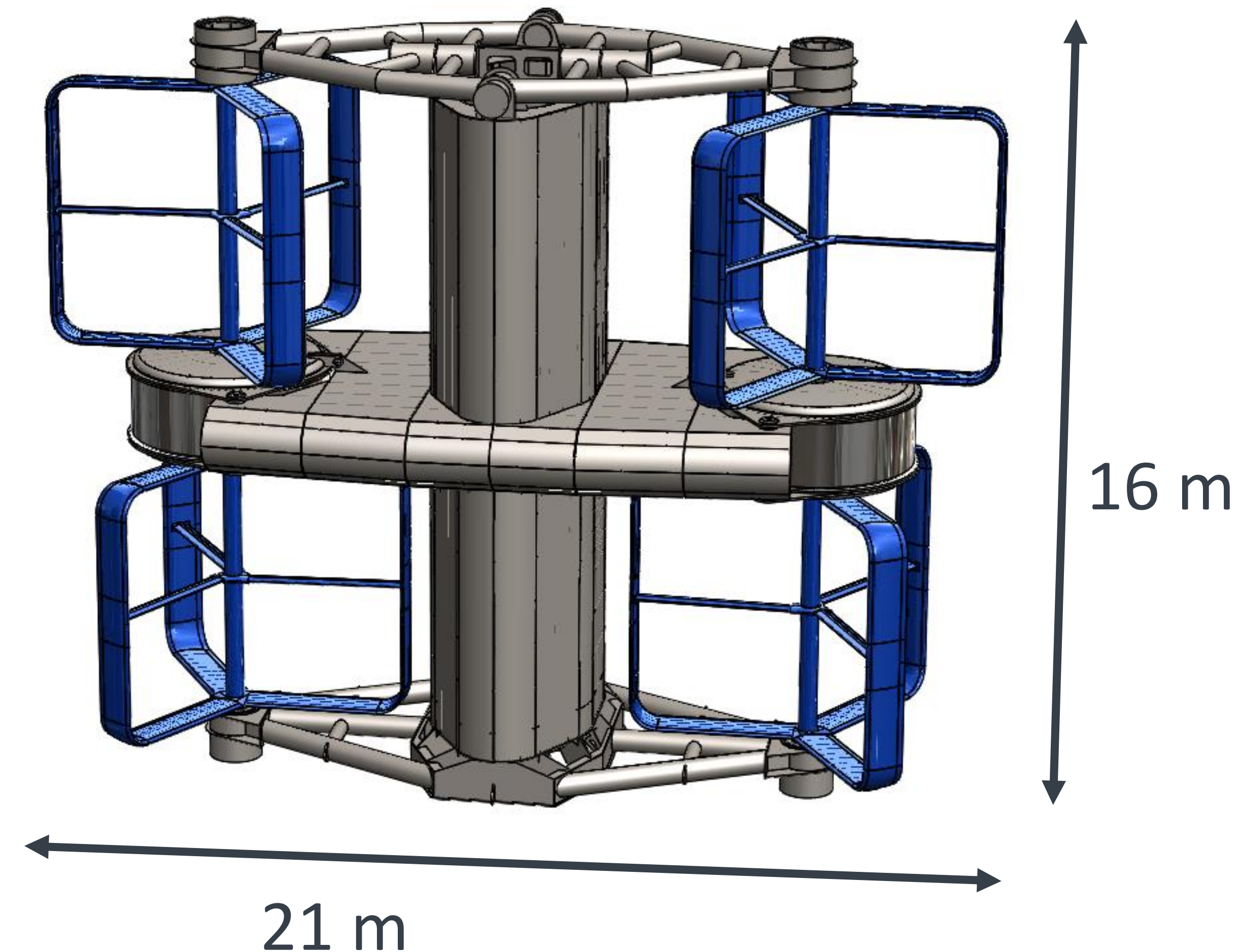
**Foundation Dry weight**

Overall dimension of 28 m x 24 m

1800 to  
2400 T

**Cast iron Ballast Dry weight**

Depending on site characteristics



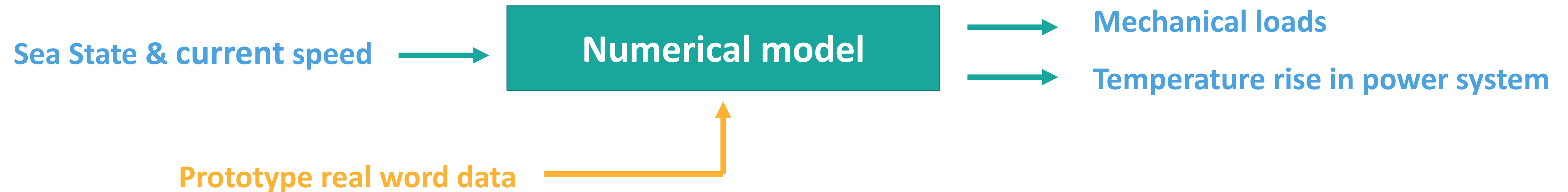


 **Project Objectives**

- 20 years service time
- Availability >95%
- Accurate P90 and P50 calculations
- Maximization of maintenance free spans

 **Implementation**

- Stronger N-1 / N-2 criteria
- Condition monitoring
- Predictive maintenance







CONCLUSION



- ▶ **Reliability by concept and by design**
  - Moving parts reduce to minimum
  - Partial redundancy strategy
  - Drive train cost optimization
  - Use of native redundancy of turbine concept
  
- ▶ **Condition monitoring**
  - Comprehensive system
  - Standardization of operation conditions
  - Predictive maintenance
  
- ▶ **Cost reduction**
  - Optimum to be found for global capex + opex minimization
  - High availability
  - Maximization of maintenance free spans
  - Reliable, data based energy production calculation





**THANKS FOR YOUR ATTENTION**

For any **information** or **quotation**, please  
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