IDOM

GRID SIMULATOR PROJECT EXPERIENCE & OVERVIEW OF MARKET NEEDS

INDEX


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IDOM

Full engineering and complete procurement, construction and commissioning of complex systems and facilities.

IDOM is an international firm specializing in Engineering, Architecture and Consulting.

IDOM operates globally in areas such as power generation, oil & gas, renewable and alternative energies, manufacturing industry, civil infrastructures, nuclear plants, large technological and scientific facilities, architecture and unique challenging engineering projects.

€290M ANNUAL TURNOVER

65 YEARS

125 COUNTRIES

45 OFFICES

4300 PROFESSIONALS

920 PARTNERS

ADA – ADVANCED DESIGN & ANALYSIS DEPT.

We offer advanced engineering for challenging projects. With a broad expertise in different areas, such as applied mechanics, mechatronics, optics & optomechanics, structural design, electronics & control, we provide engineering and turnkey supply solutions to a wide range of customers worldwide. The experience in diverse areas enables us to push our creative skills to the uttermost in a hybridizing and cross-innovation scheme. In this context we provide solutions within our division of Test Systems & Special Machinery.

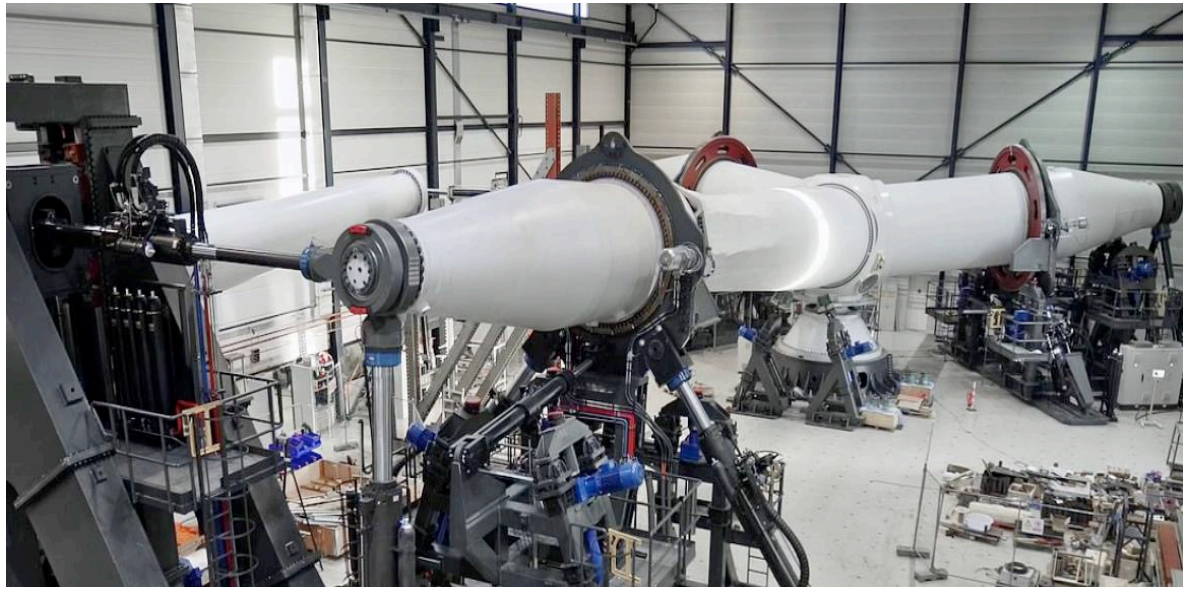
Test Systems & Special Machinery Division

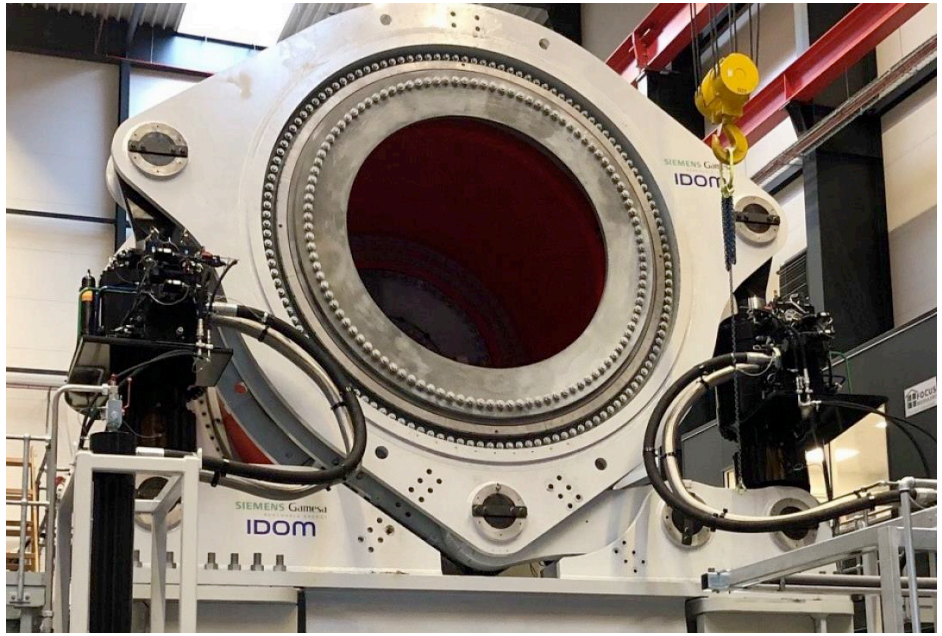
Within the Advanced Design & Analysis Department, **Test Systems & Special Machinery Division** designs and builds technological facilities designed to test a wide variety of prototypes of new products and advanced technologies. We accompany the client from the initial conceptual stages to the final hand over, developing the entire test facility as well as modern test benches for pioneering research centres and existing production facilities.

REFERENCES

TEST SYSTEMS

ONSHORE WIND TURBINE ROTOR TEST BENCH
CLIENT: LM WIND POWER
SCOPE: EPC
COUNTRY: NEDERLANDS



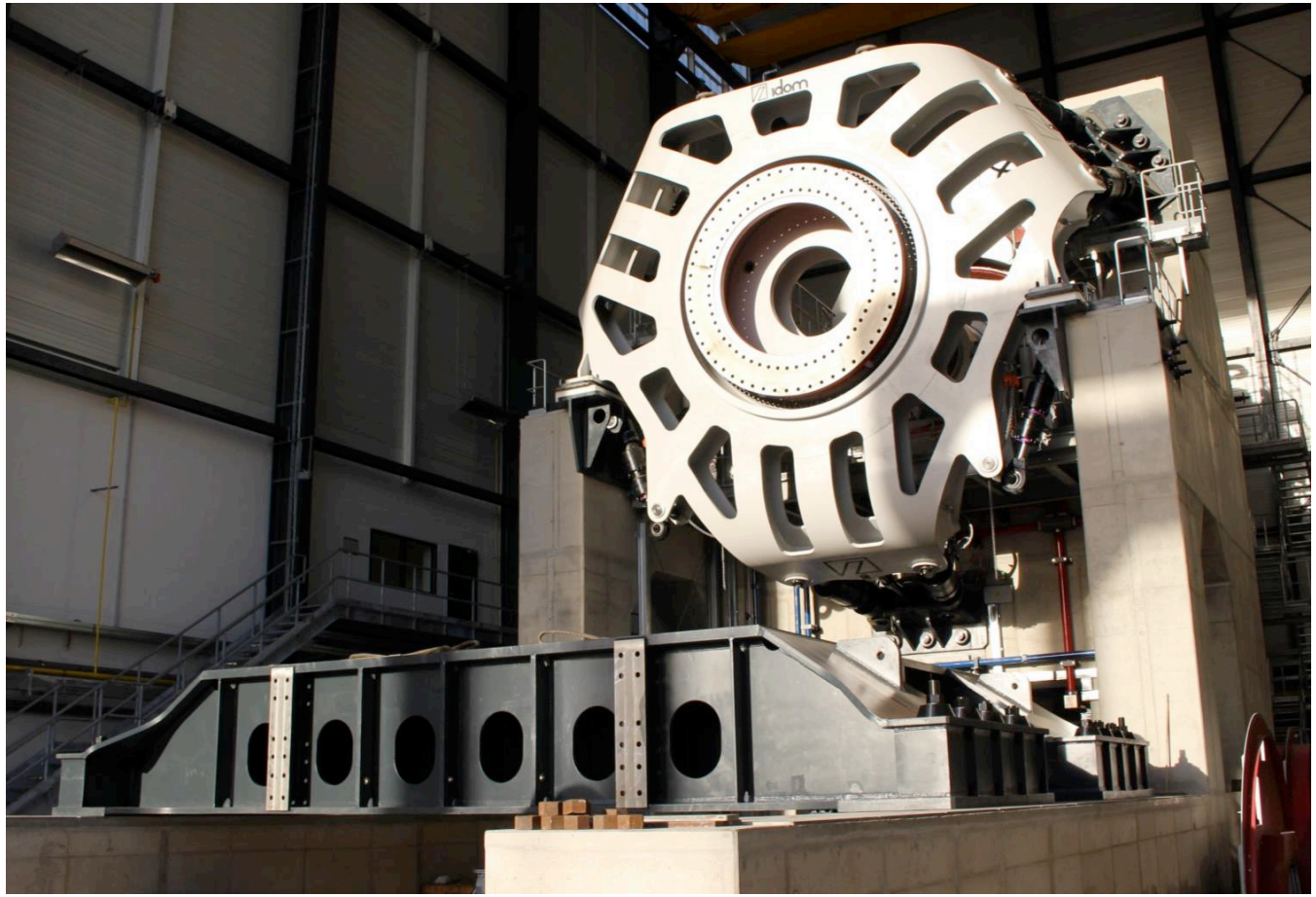


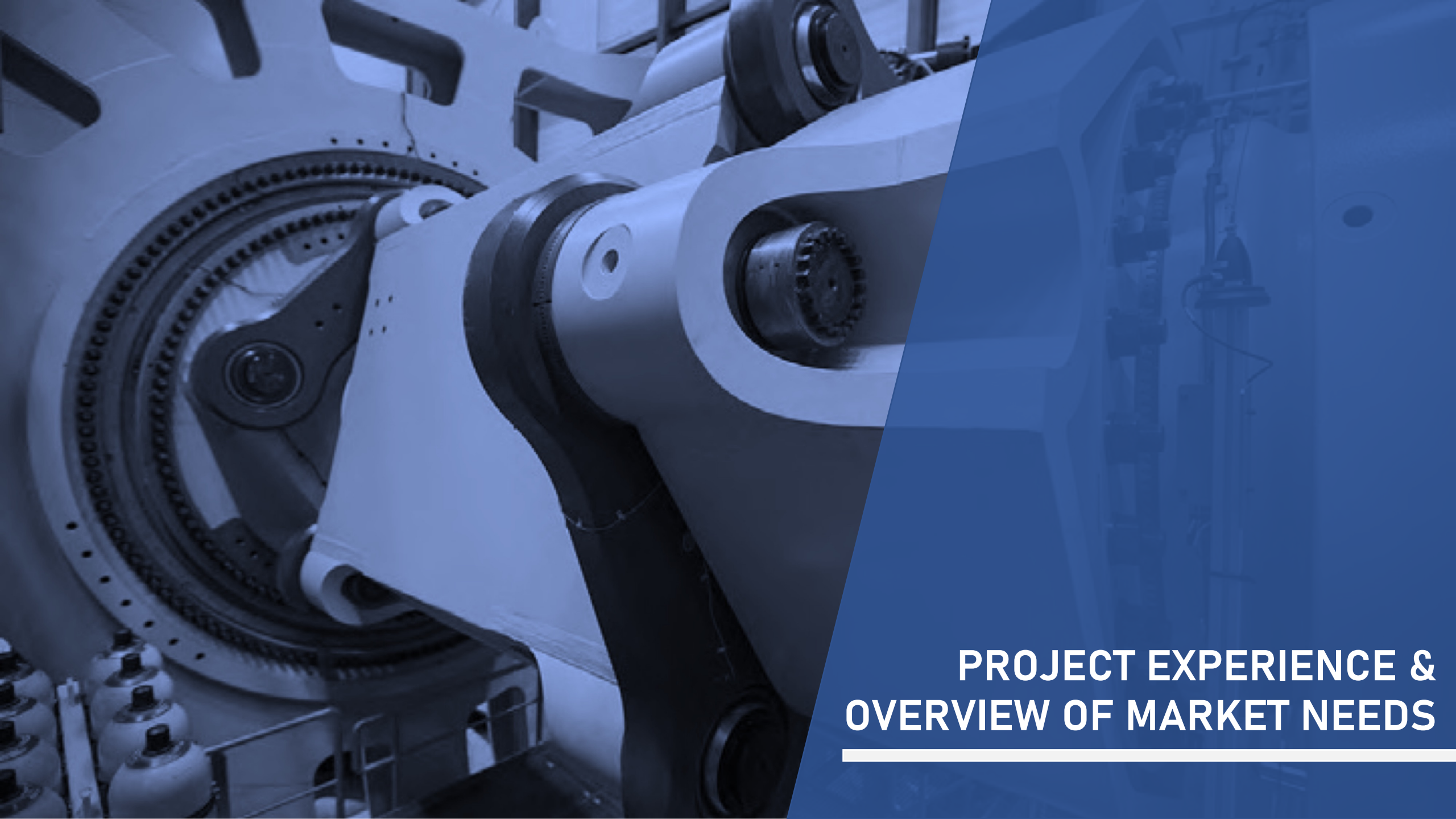
LOAD APPLICATION SYSTEM FOR MAIN BEARING TEST BENCH
CLIENT: SIEMENS GAMESA
SCOPE: EPC
COUNTRY: DENMARK

REFERENCES

TEST SYSTEMS

DYNALAB DRIVE TRAIN TEST BENCH
CLIENT: FRAUNHOFER IWES
SCOPE: EPC – TEST BENCH & FACILITY
COUNTRY: GERMANY





PROJECT EXPERIENCE & OVERVIEW OF MARKET NEEDS

POWER

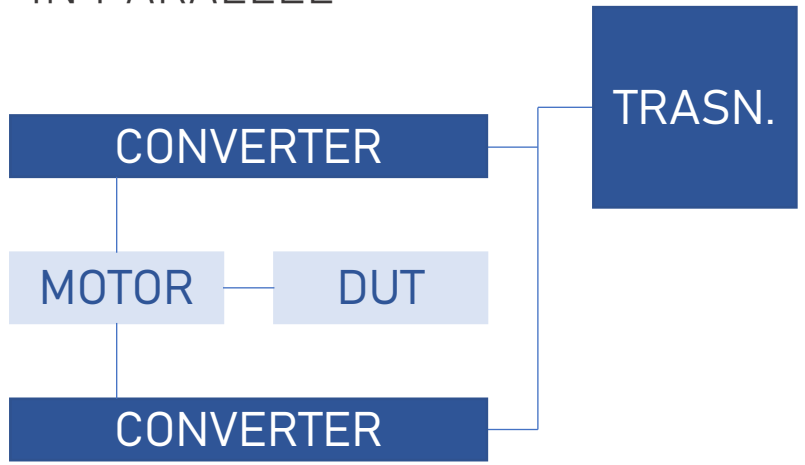
30 MW TEST BENCH

GRID SIMULATOR REQUIREMENTS:

- ✓ NOMINAL VOLTAGE**:** 33 KV / **66 KV**
- ✓ NOMINAL POWER: **40 MVA**

66 KV: GAS INSULATED SWITCHGEAR (GIS)

40 MVA: 2 CONVERTERS IN PARALLEL



VERSATILITY

WIND & RAILWAY TEST BENCH

GRID SIMULATOR REQUIREMENTS:

- ✓ **WIND APPLICATION:**
  - ✓ THREE PHASE MOTOR
  - ✓ THREE PHASE GENERATOR
- ✓ **RAILWAY APPLICATION:**
  - ✓ THREE PHASE MOTOR
  - ✓ **SINGLE PHASE GENERATOR**

CONTROL

REQUIRED FEATURES OF THE CONTROL INTERFACE:

- ✓ **CONTROL SOURCE:** ETHERCAT / **HIL**
- ✓ **MODULATION TYPE:** PWM / OPP
- ✓ **TRANSFORMER IMPEDANCE COMPENSATION**
- ✓ **TAP CHANGER POSITION**
- ✓ **DETERMINISTIC COMMUNICATION**

UPGRADABILITY

- ✓ MOBILITY
- ✓ MODULAR DESIGN
- ✓ ADAPTABILITY

MOBILE TEST VESSEL FOR CURRENT ENERGY CONVERTERS

IDOM MARINE ENERGIES

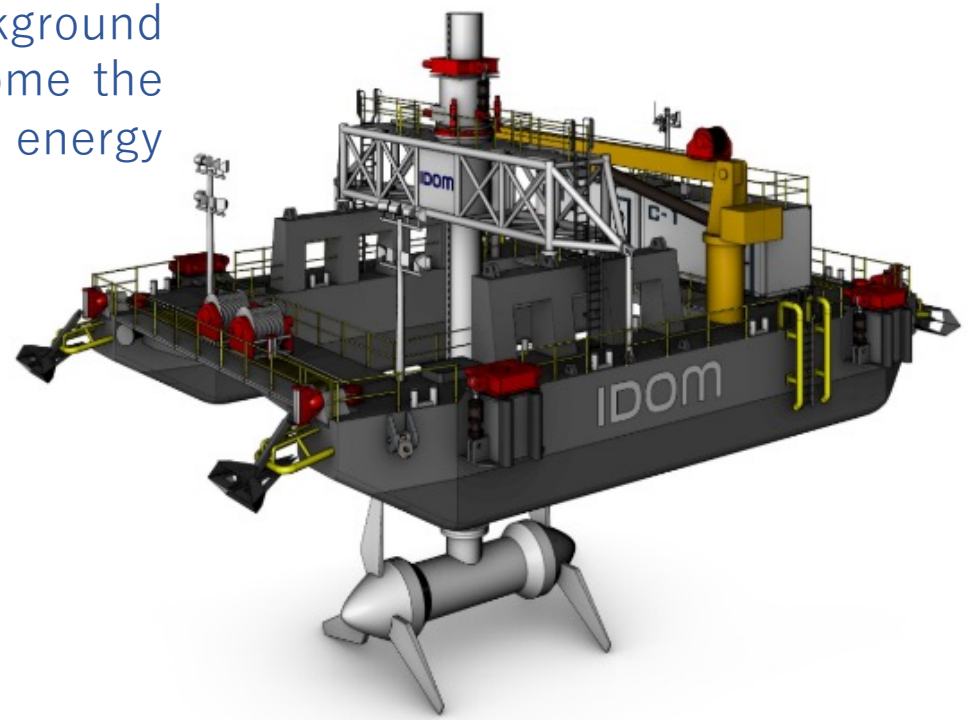
Activities around Marine renewables started 11 years ago with the development of a wave energy harvesting technology

The extensive research of a committed team has led to the achievement of a proven OWC Wave Energy Converter (MARMOK A-5), offshore material test platform (HarshLAB 2.0) etc.

IDOM
Marine Energies

IDOM MARINE ENERGIES

IDOM's extended experience in marine energy and wide background on testing facilities has led to becoming the leader to overcome the challenge of developing a unique mobile test vessel for current energy converters.



Main characteristics:

Duration: Starting date Oct-2021
Expected End date Sept-2025

Funding opportunity: Under FOA-002234

Supporting partners and institutes:

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Pacific Northwest NATIONAL LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Sandia National Laboratories

Final MTV operator:

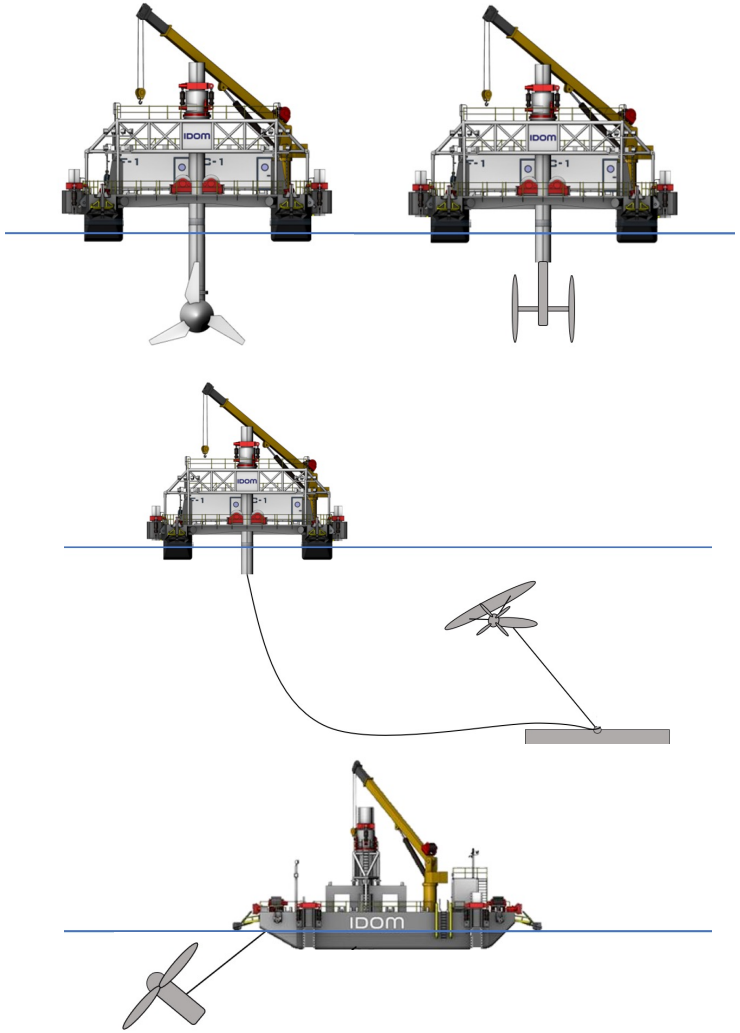
FAU SOUTHEAST NATIONAL MARINE RENEWABLE ENERGY CENTER

DESIGN KEY POINTS

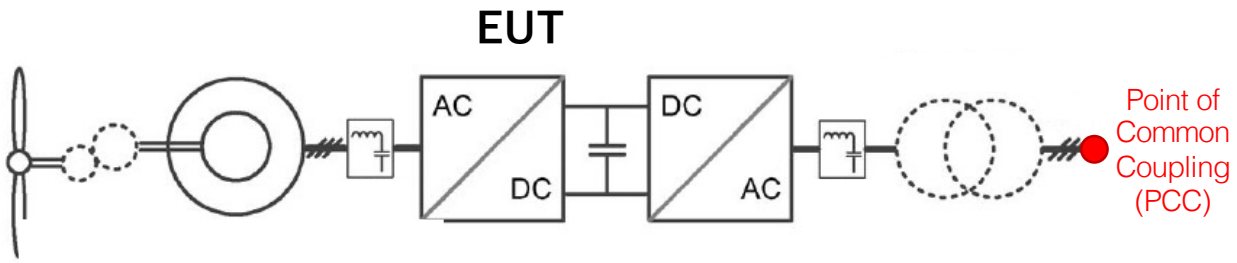
MTV will be an adaptable infrastructure for testing any promising CEC technology. Overcoming the infrastructure need for real environment testing.

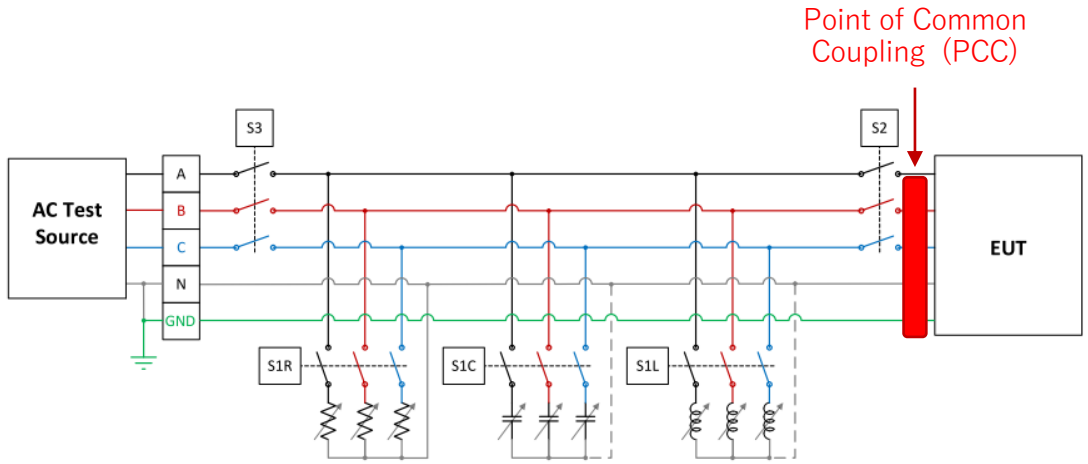
Key characteristics:

- ✓ Support on the testing of all turbine types
- ✓ Test horizontal, vertical, and cross flow turbines with rotors up to 8 meters
- ✓ Be adaptable for utilization at river, tidal and ocean test sites
- ✓ Operate in a wide variety of current speeds up to 4 m/s, water depths, wave conditions and bottom types, etc.
- ✓ Non propelled vessel but with an onboard power generation.
- ✓ Off-grid grid simulator onboard under development
- ✓ Internal / External Mooring (Jack-Up legs could be available)



CEC TEST SYSTEM





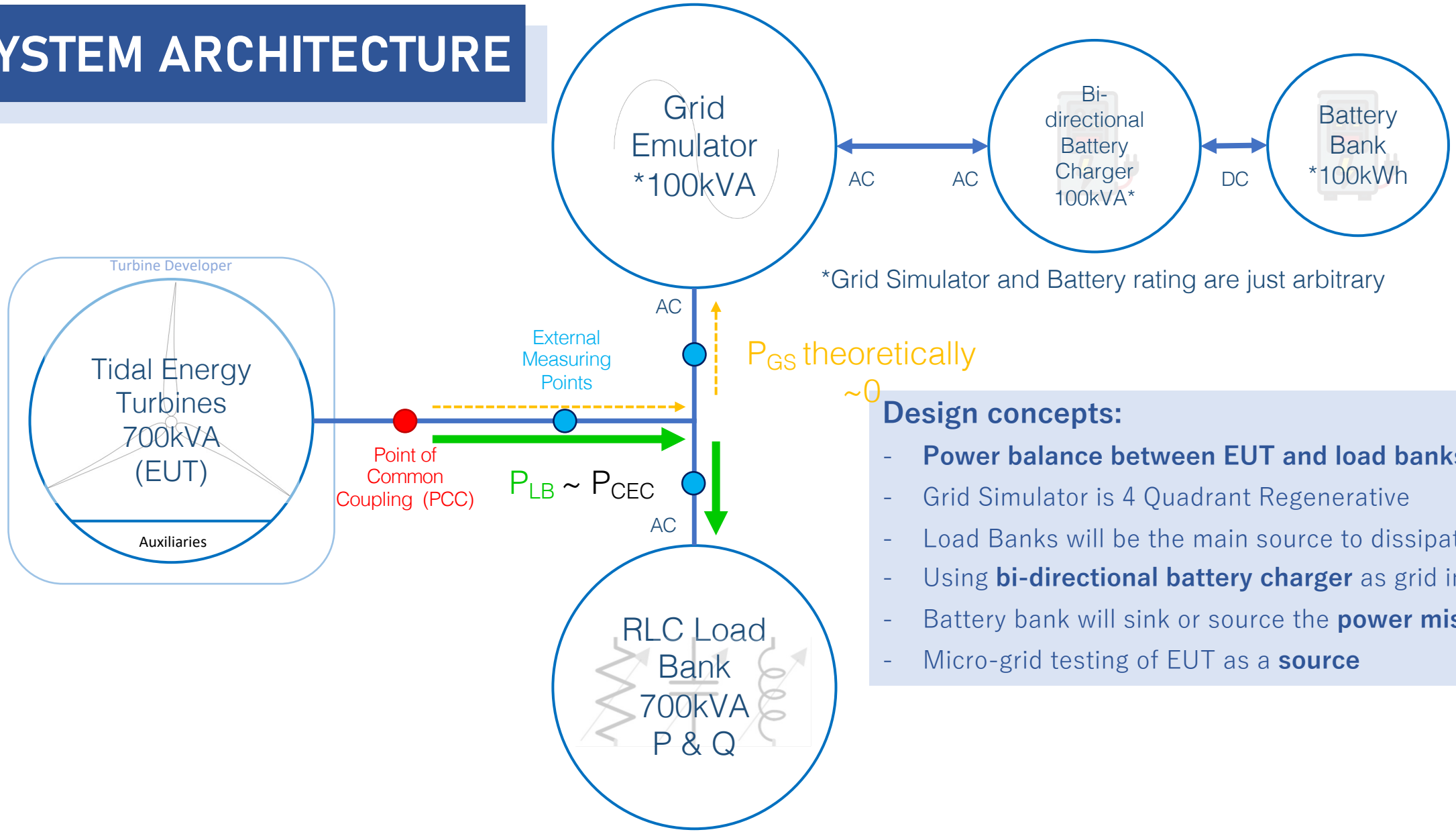
Highlights:

- Allow developers to evaluate performance of technologies categorized under **IEC 62600 (TC 114)**
- Facilitate current energy turbine testing at **various location**
- Designed for maximum DER output of **700kVA**
- Assuming DER is an **Inverter Based Technology**
- Grid connection is **not available**

Perform tests for conformance with **IEEE 1547**

- Criteria and requirements for the interconnection of **distributed generation resources** into the power grid
- Main clauses in 1547-2018:
  - 4 General Requirements
  - 5 Reactive power capacity and PQ/V control
  - 6 Response to Area EPS abnormal conditions
  - 7 Power Quality
  - 8 Islanding
- Test system is designed in accordance to **1547.1-2020**

SYSTEM ARCHITECTURE



Design concepts:

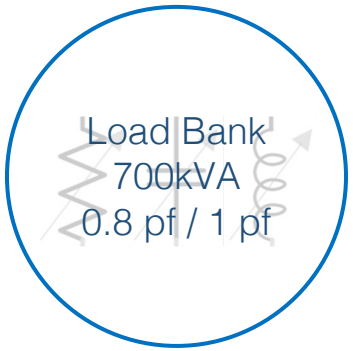
- **Power balance between EUT and load banks** is crucial
- Grid Simulator is 4 Quadrant Regenerative
- Load Banks will be the main source to dissipate energy
- Using **bi-directional battery charger** as grid interface
- Battery bank will sink or source the **power mismatch**
- Micro-grid testing of EUT as a **source**

SYSTEM ARCHITECTURE

Baseline Design

Not aimed at standard compliance
Simple EUT Performance Monitoring

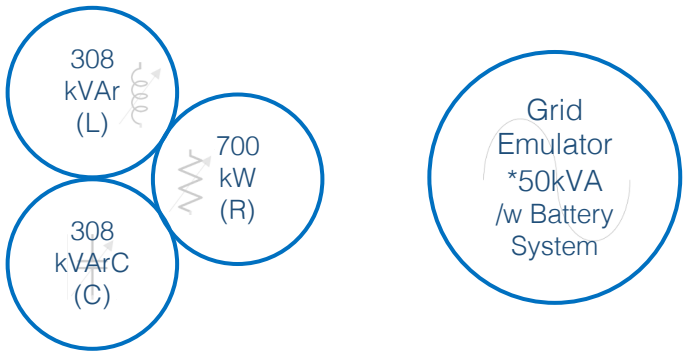
Typical generator test parameters:
Full Load @ 0.8 pf / 1pf



Intermediate Design

IEEE1547-2018 Compliance
Clause 4-7

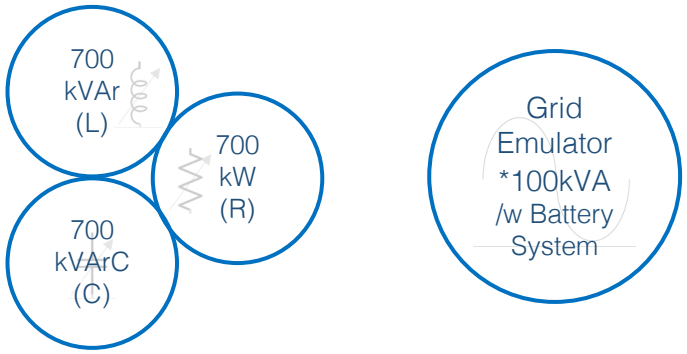
Technical Requirement:
Grid Simulator (AC Test Source)
- P: 1 p.u.
- Q: 0.44 p.u. & -0.44 p.u.



Topline Design

IEEE1547-2018 Compliance
Clause 4-8 Including Islanding

Technical Requirement:
Grid Simulator (AC Test Source)
P: 1 p.u.
Q: 1 p.u. & -1 p.u.



DESIGN CHALLENGES

Technicality:

- ✓ System stability of 3 closed-loop controllers (Grid forming & Grid following)
- ✓ Frequency Bandwidth
- ✓ Intense coordination required
- ✓ Overstressing the grid simulator
- ✓ Maintain battery SOC at safe levels during test durations entirely
- ✓ High precision and fast processing controller required to maintain power balance
- ✓ Communication between controllers of different manufacturers

Practicality:

- ✓ Potential negative effect to the test system is unknown in the maritime environment
- ✓ Physical protection from the environment
- ✓ Test System aimed to be fully autonomous or to be controlled remotely
- ✓ Ship is designed to be unmanned

THANK YOU VERY MUCH FOR YOUR ATTENTION!

ANY QUESTIONS?

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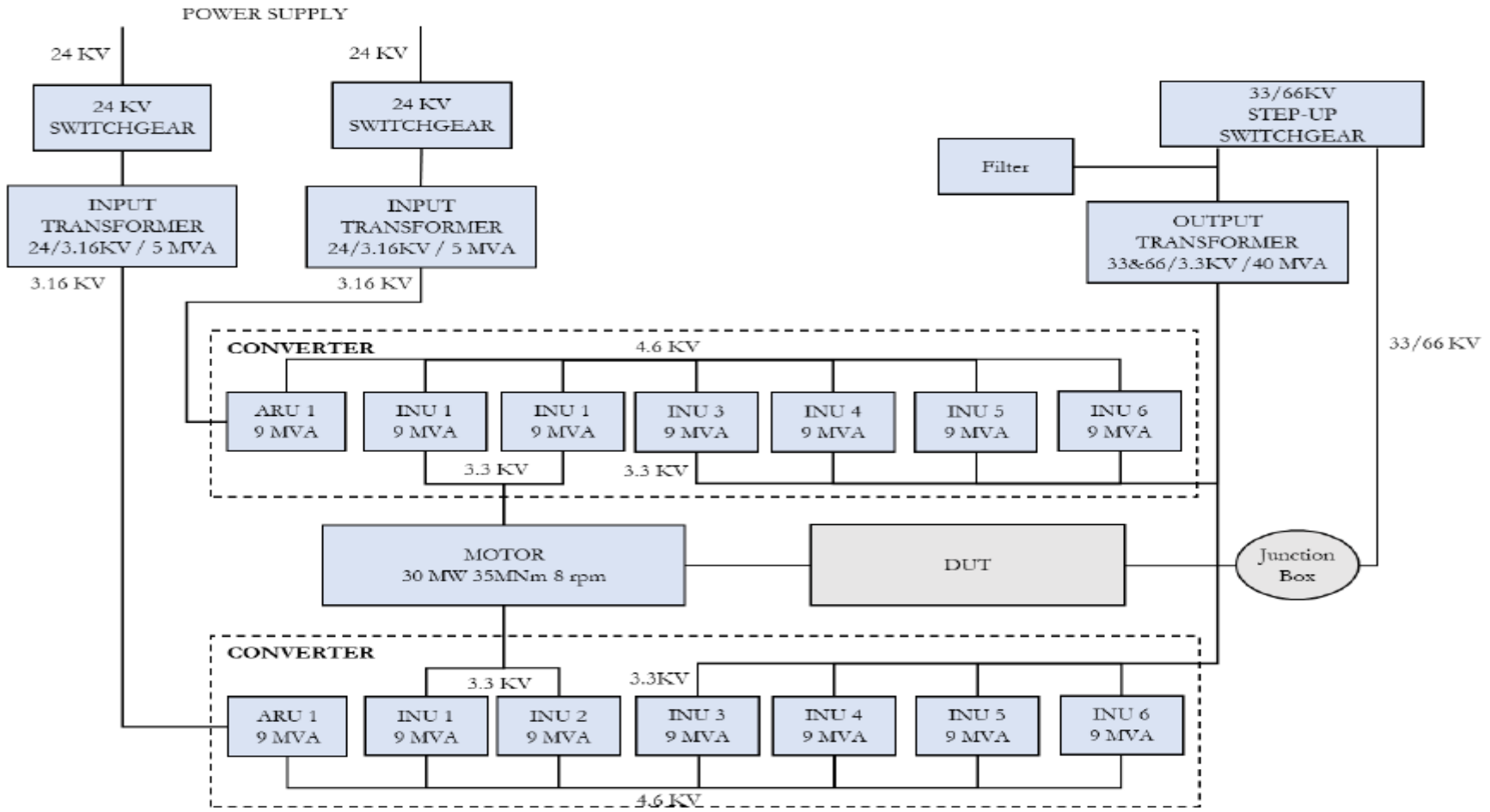
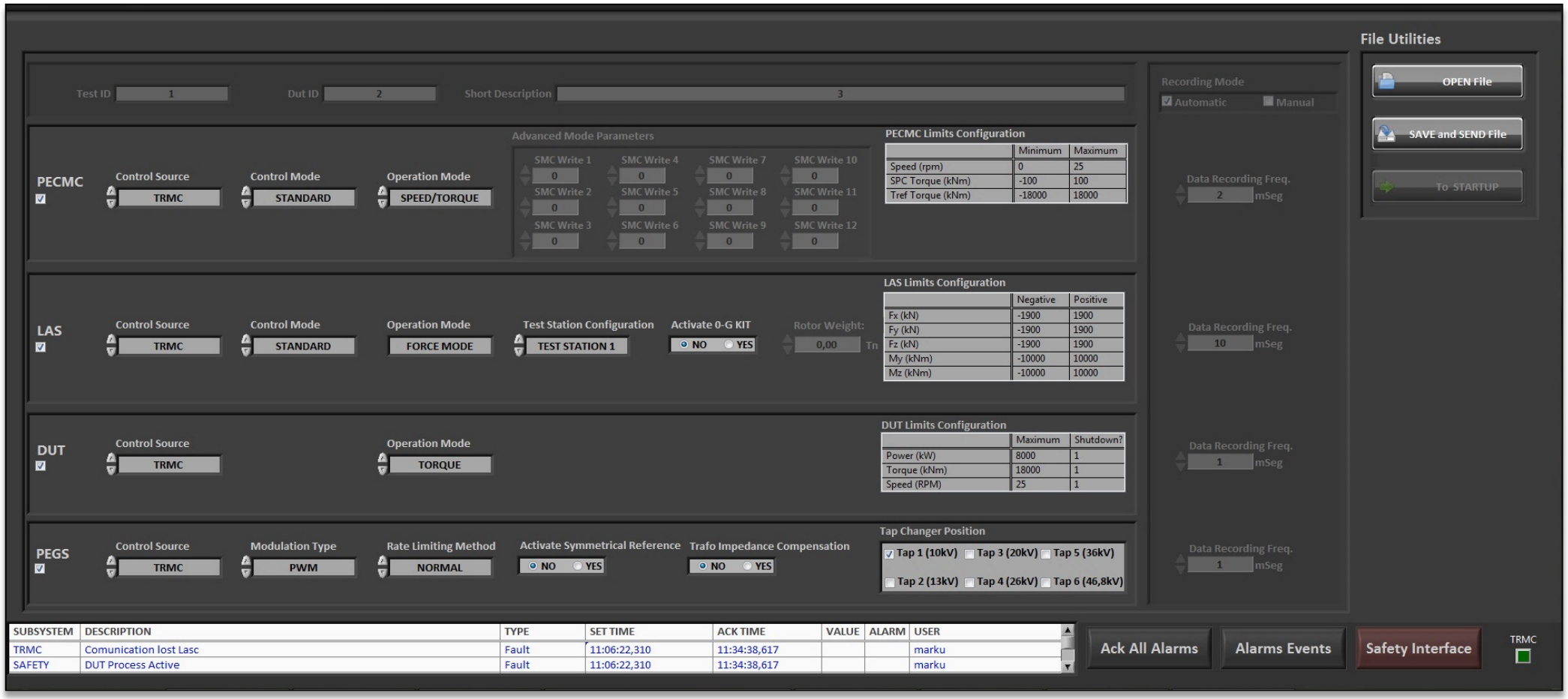
ANNEX

30 MW TEST BENCH – DIAGRAM



ANNEX

HMI CONFIGURATION SCREEN



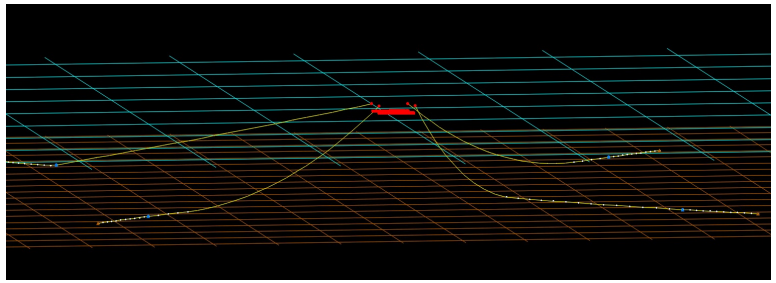
ANNEX

MTV MOORING

Anchoring and mooring system designed for current speeds and water depths at all agreed to test sites, and a jacking system designed for current speeds, water depths, and bottom types for all agreed to test sites.

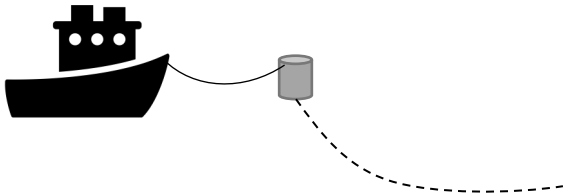
Internal Mooring System (IMS)

- Shallow water
- Due to current direction inversion, a four-point mooring proposed
- Elements:
  - Chain to seabed
  - Cable to vessel



External Mooring System (EMS)

- Deep water
- Site to site evaluation
- Possibility of:
  - **Single point mooring**, using bridle and winches to support the operation
  - **Four-point mooring** design, if the mooring is provided by an external vessel connecting to padeyes.



Jack-up legs

- Rivers and estuaries
- Depths up to 13 m