The Power Platform
Offshore Renewable Energy's Future

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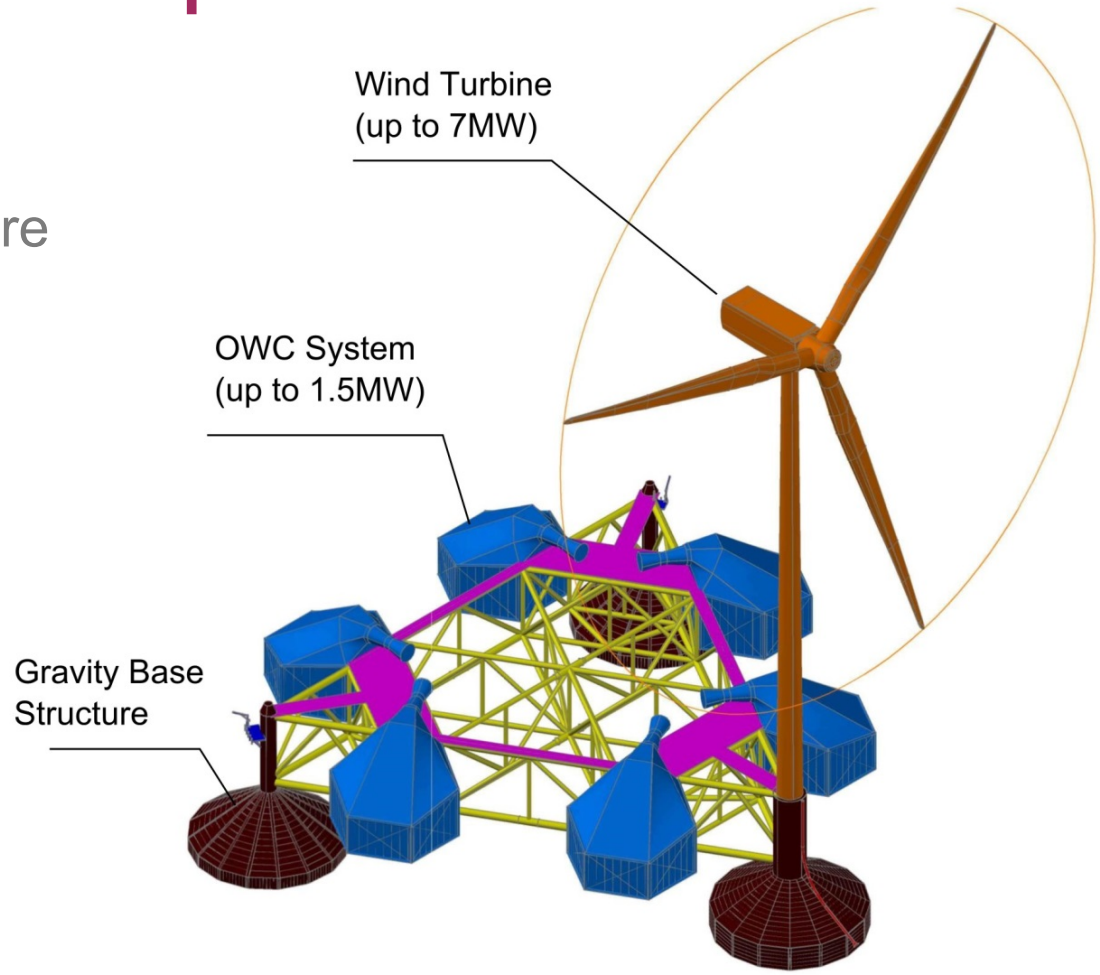
Agenda

- Overview of the Concept
- Global Renewable Solutions (GRS)
- Wood Group Kenny (WGK)
- WGK Scope of Work
- GRS Scope of Work
- Next Steps

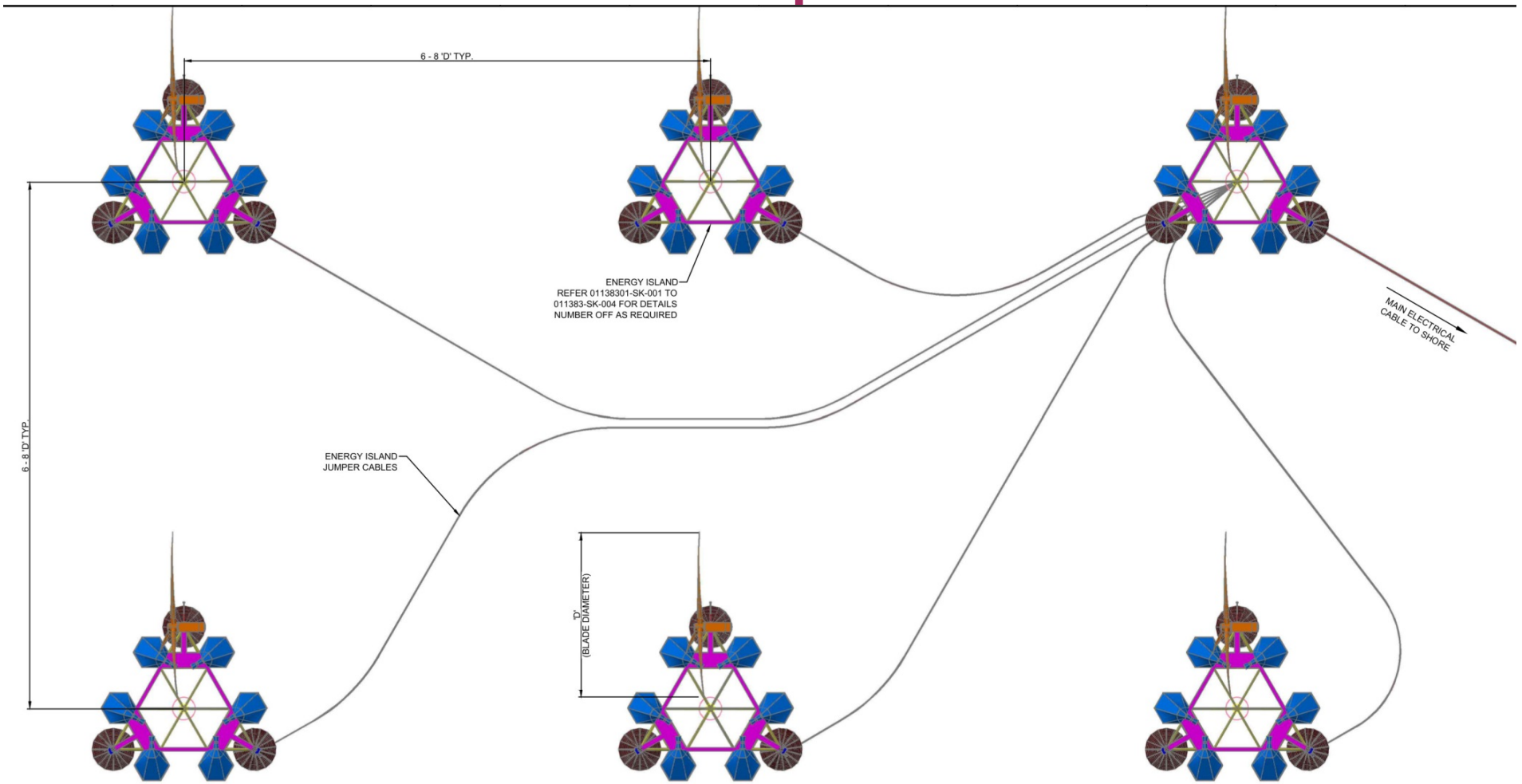
Overview the concept

Integrated System:

- Steel Gravity Based Structure
- Wind – 1x Wind Turbine
- Wave – 6 x OWCs
- Water Depth 20 – 30 m



Overview the concept



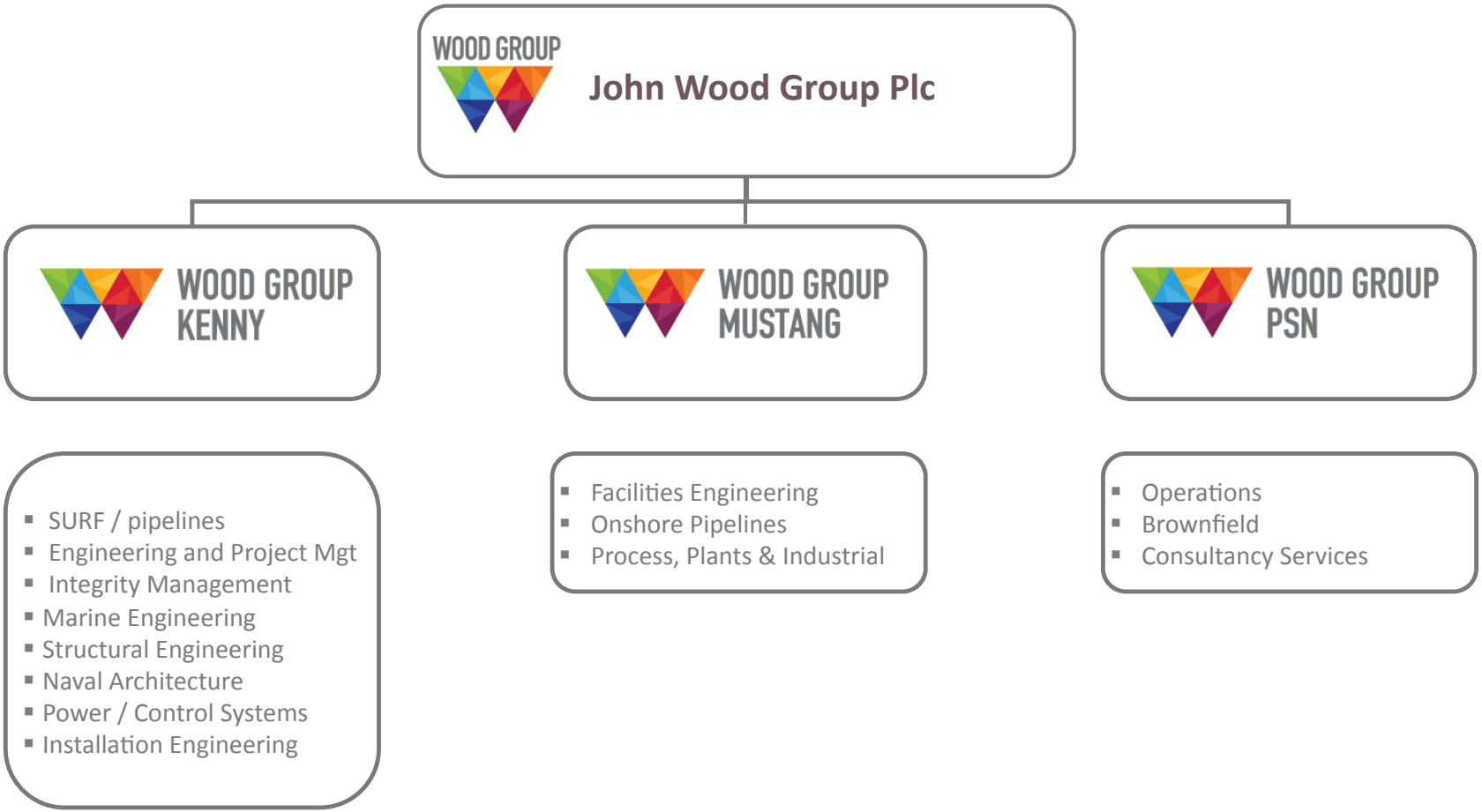
About GRS

Global Renewable Solutions:

- Australian and Irish Registered
- Patented technology
- Integrators rather than Developers

About WoodGroup

43,000 employees in 50 countries with revenue circa. $7 billion



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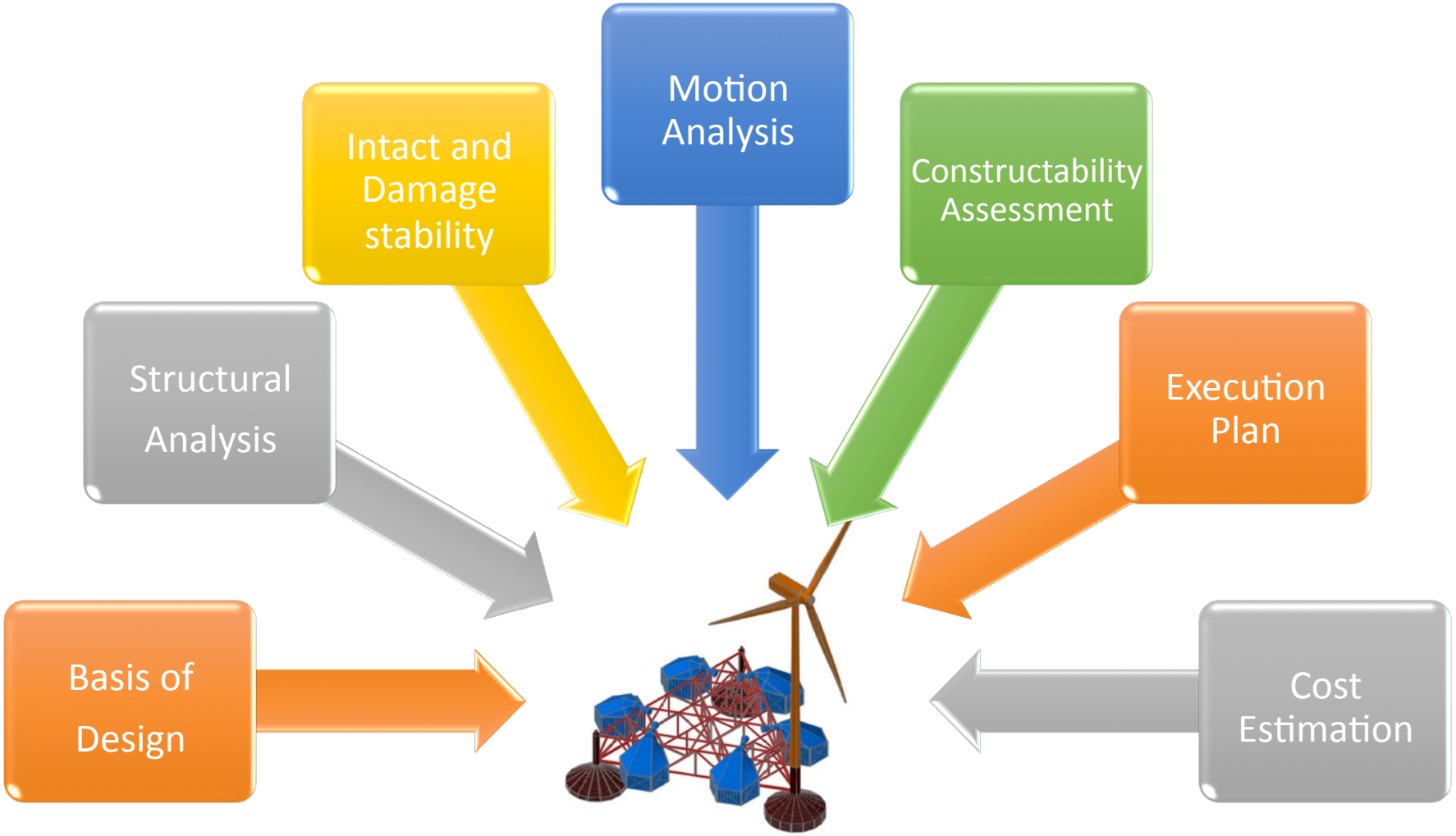
Conceptual Work

WGK Scope


Motion Analysis
Intact and Damage stability
Constructability Assessment
Structural Analysis
Execution Plan
Basis of Design
Cost Estimation

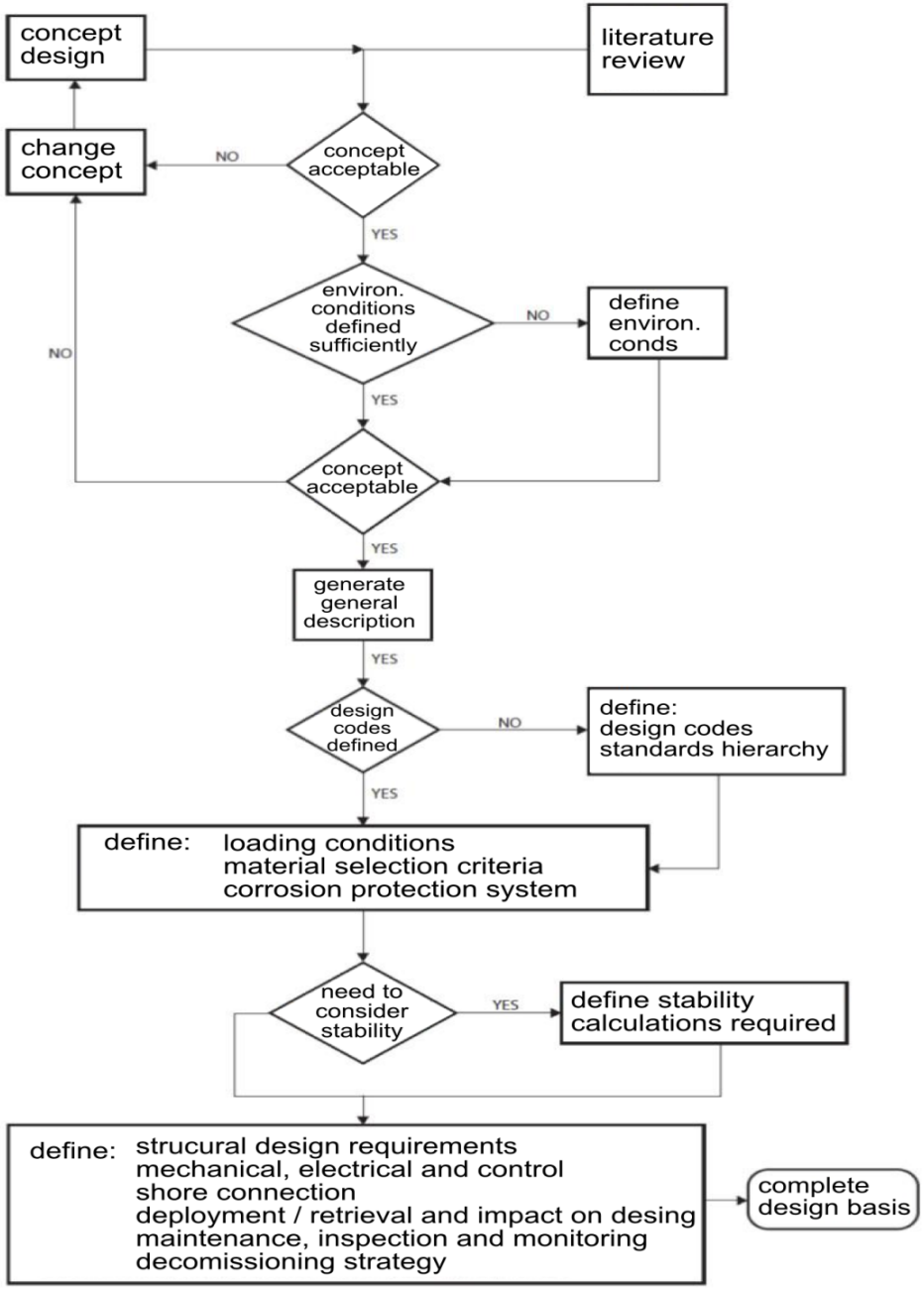
Basis of Design

Consolidates the **key design data** used for conceptual engineering.

Prime focus on minimising CAPEX and OPEX, while presenting a robust and safe concept.

CAPEX steelwork, wind turbines, OWC turbines, electrical power cable, transportation, installation, commissioning.

OPEX maintenance frequency



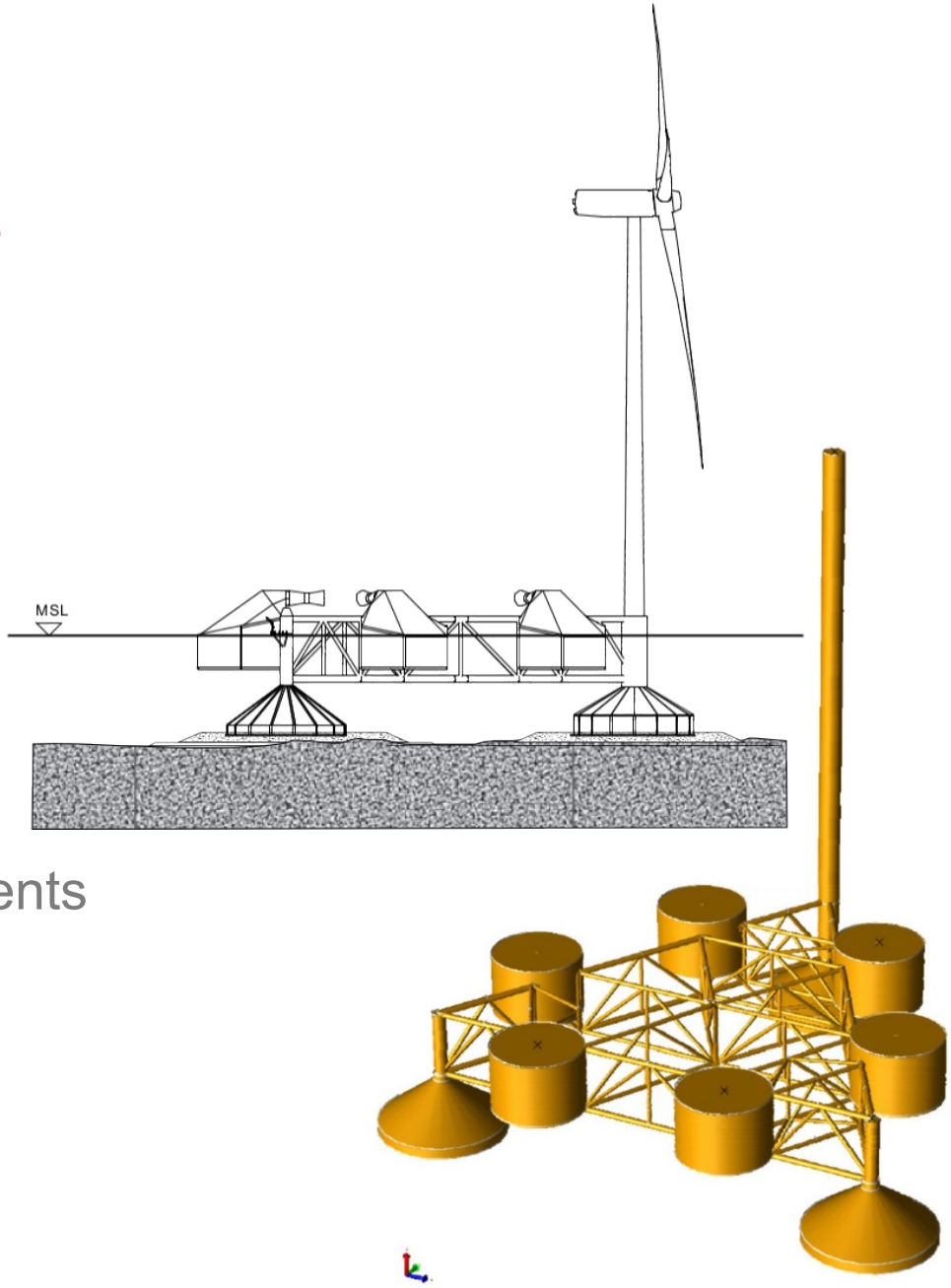
Structural Analysis

Design Criteria:

- In-place Storm Survivability
- Towing and Installation Strength
- Foundation Engineering

Prelim Analysis to provide:

- Sizing for the structural components
- Estimate overall weight for
  - other engineering analyses
  - cost estimation

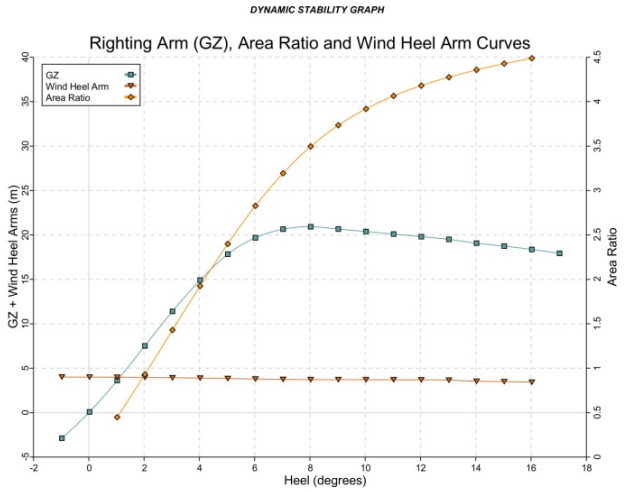


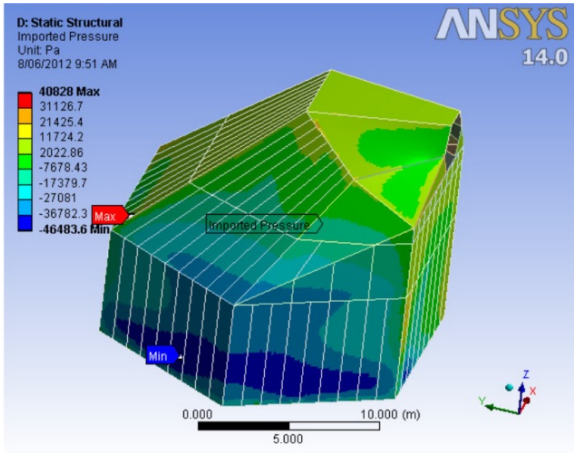
Engineering Approach

Offshore and O&G industry procedures, analyses and assessments
combined with:

- innovative approaches
- guidelines for renewable energy systems

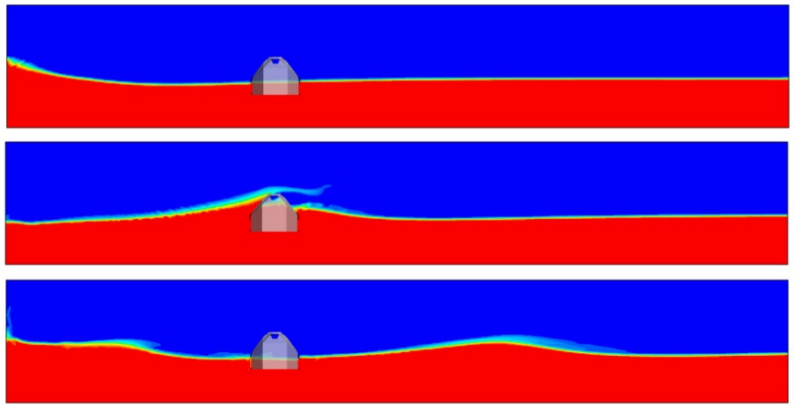
Global and local models:
Detailed CFD
FEA methods
Structural software
Hydrodynamic simulations





Engineering Approach

CFD model for
Analysis of the OWC chambers located within the wave splash zone subject to constant wave impact



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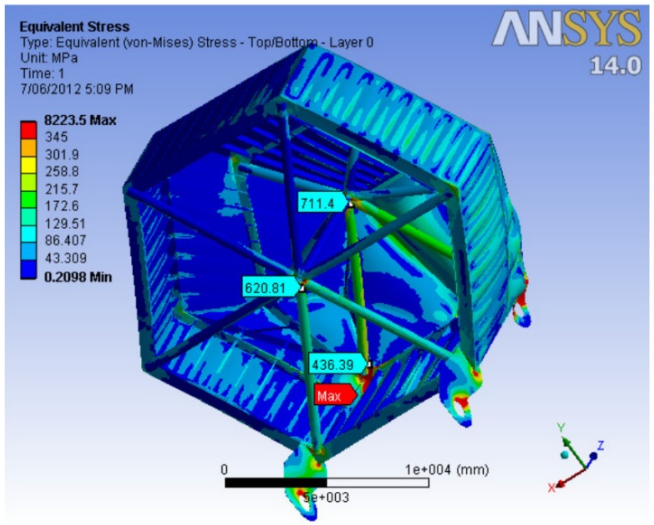


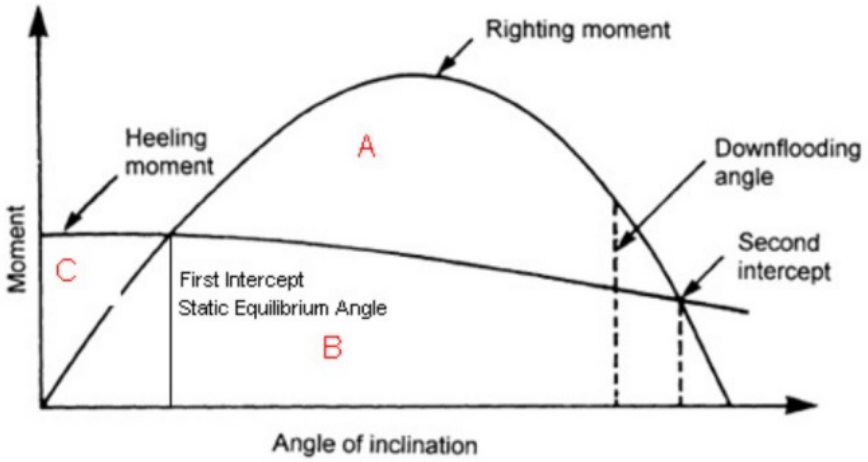
Loads were then transferred to an FE model for structural analysis

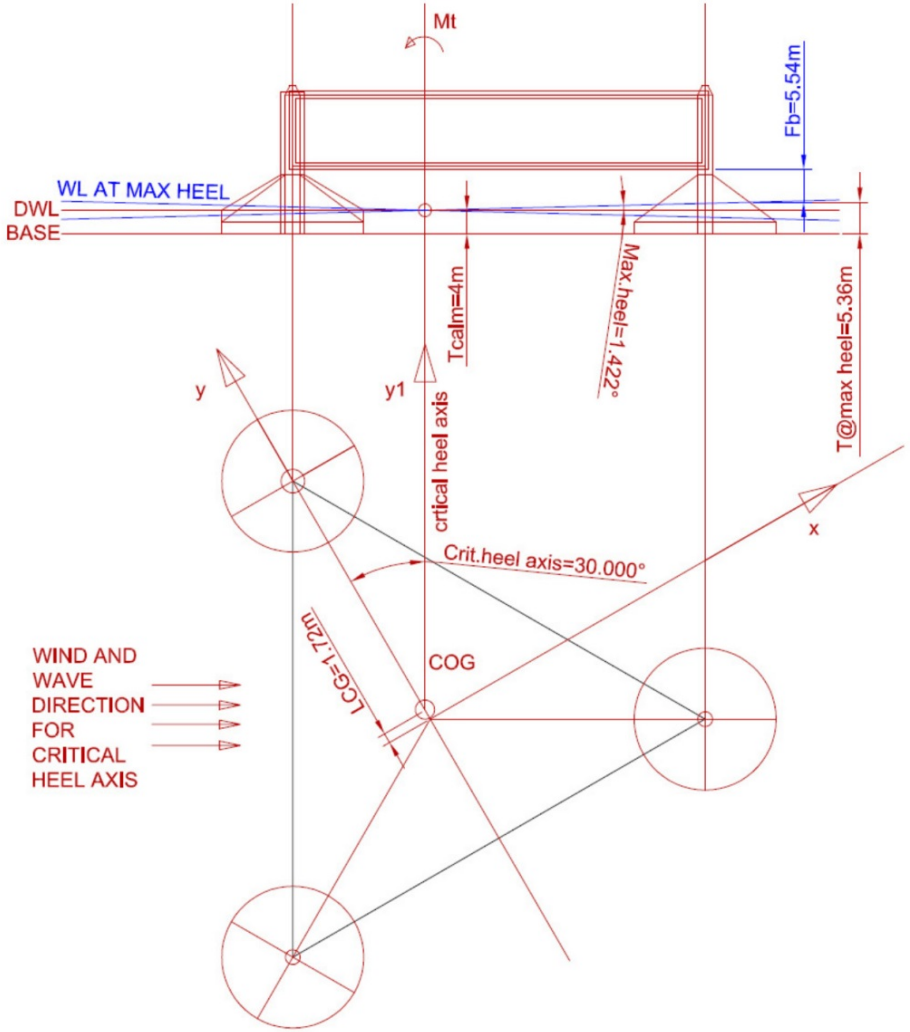
Intact and Damaged Stability

Hydrostatic stability during the tow and prior to installation

Ensure sufficient stability for possible scenarios

Define the suitable ballast for wet towing under extreme conditions





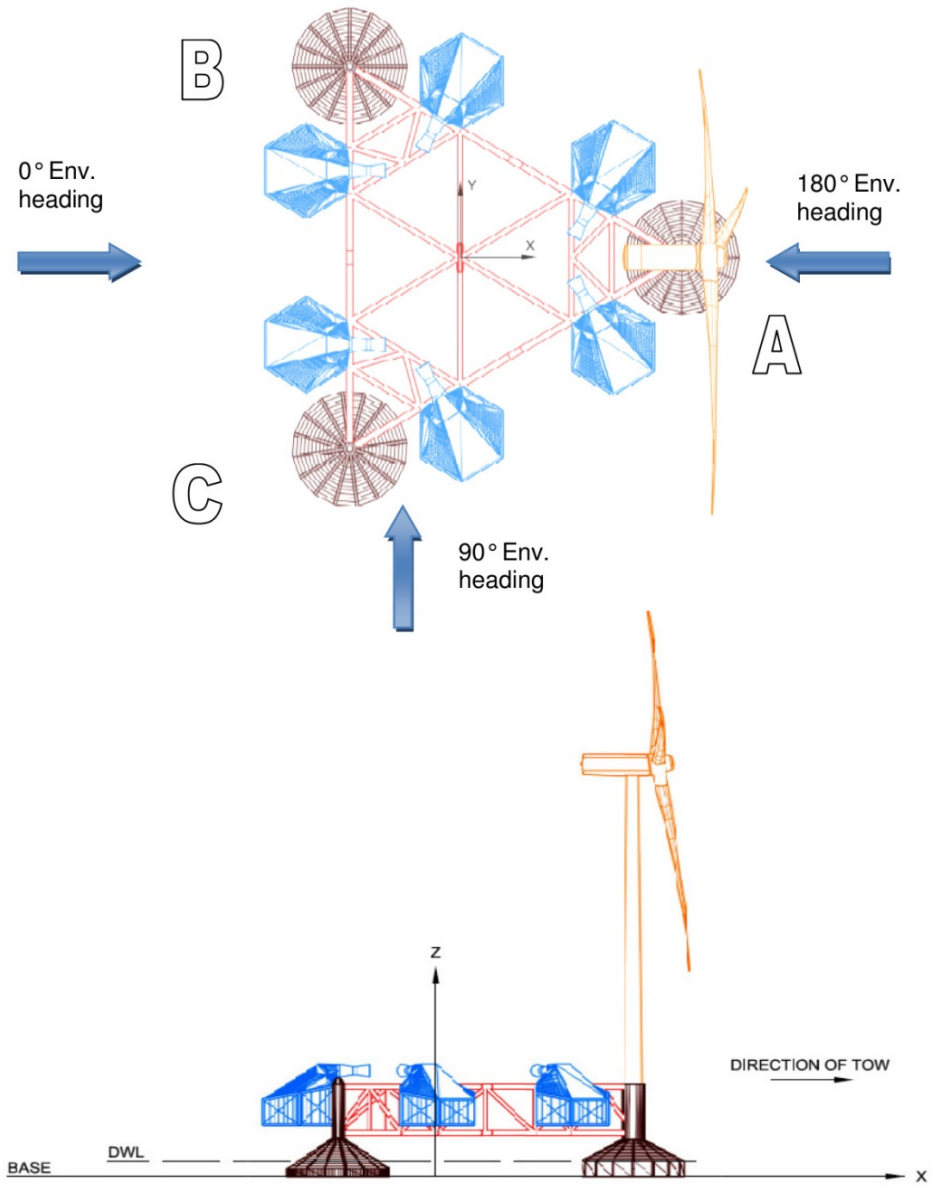
Motion Analysis

Hydrodynamic and motions analyses at free floating and towing

Challenge:
novel geometrical shape + wind turbine assembly installed at high elevation.

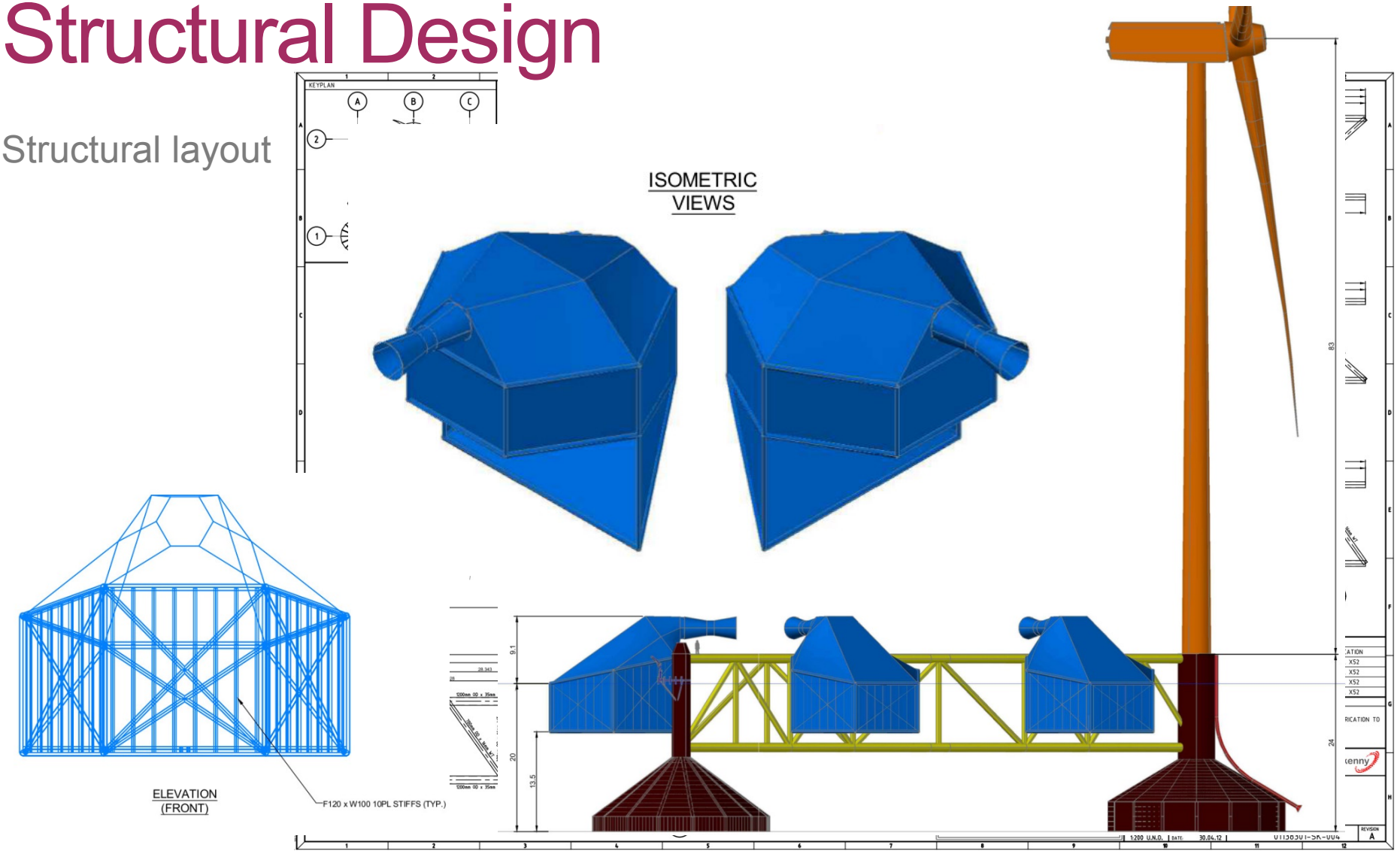
Output:
RAOs, added mass, damping and stiffness matrices

Goal:
Determining response in various sea state conditions



Structural Design

Structural layout



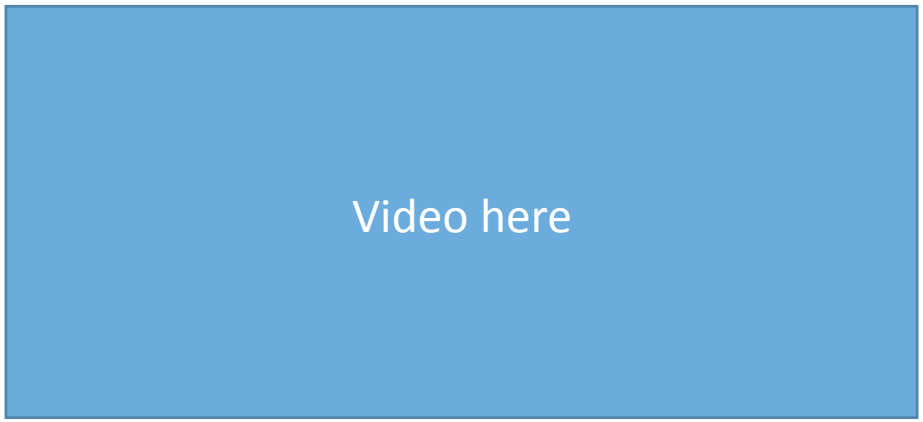
Constructability

Possible and likely methods of construction based specific regional methods

Includes all the aspects

Strategy to eliminate the need for any large marine lifting equipment

Concept to be fully assembled, pre-commissioned and tested before being transported to site and installed

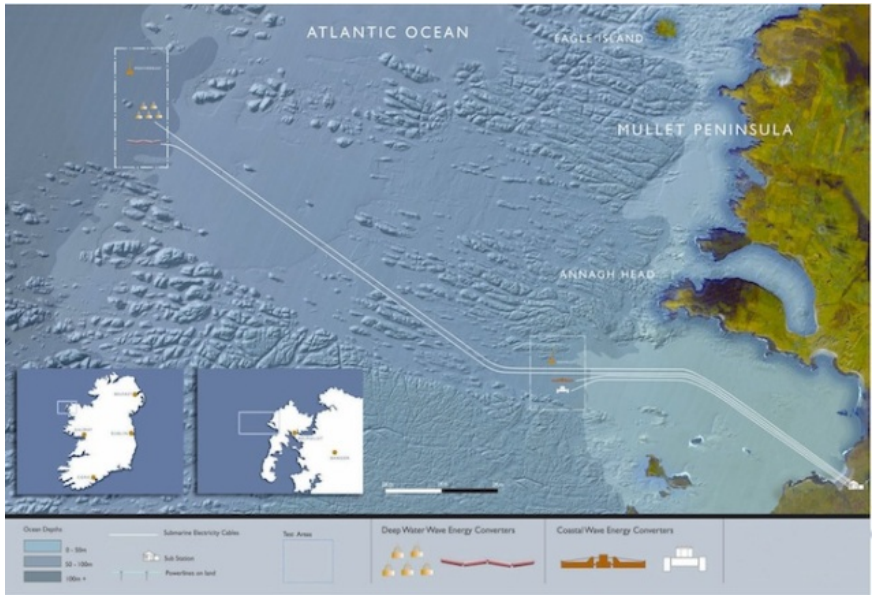


Execution Plan

to procure, fabricate, transport and install the Power Platform structure and its components

Recommendations

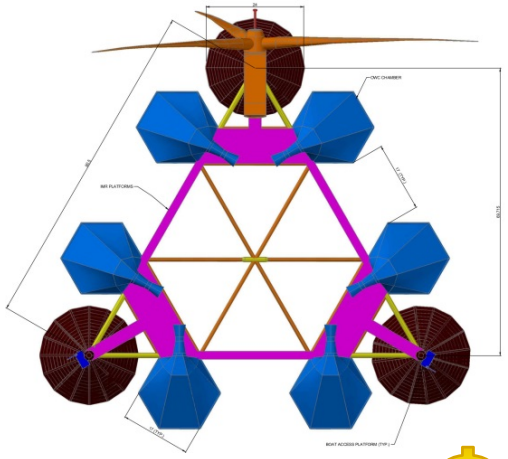
- prequalify contractors
- investigate local capabilities
- perform studies
- engage Marine Warranty Surveyor early
- establish crane capabilities



Cost Estimate

Definition of the basis for costs and cost estimation

Costs were calculated for both an individual and for 6 units



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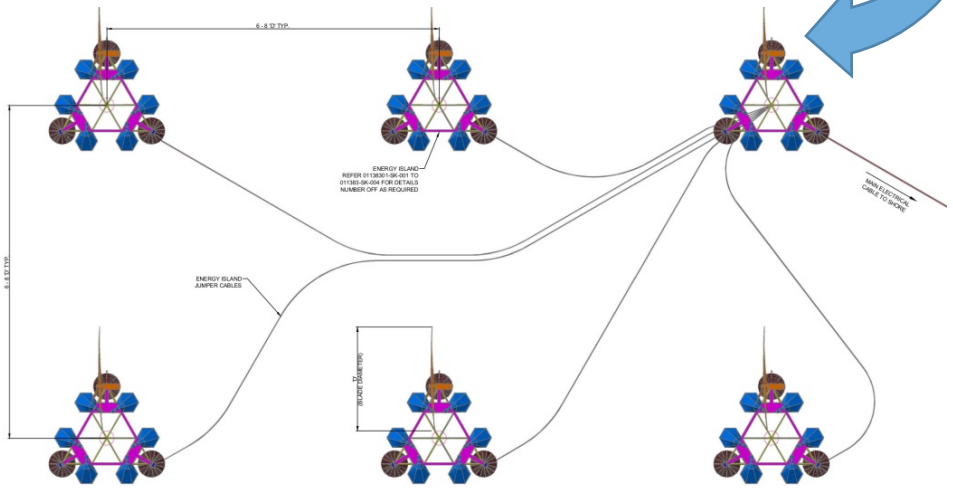

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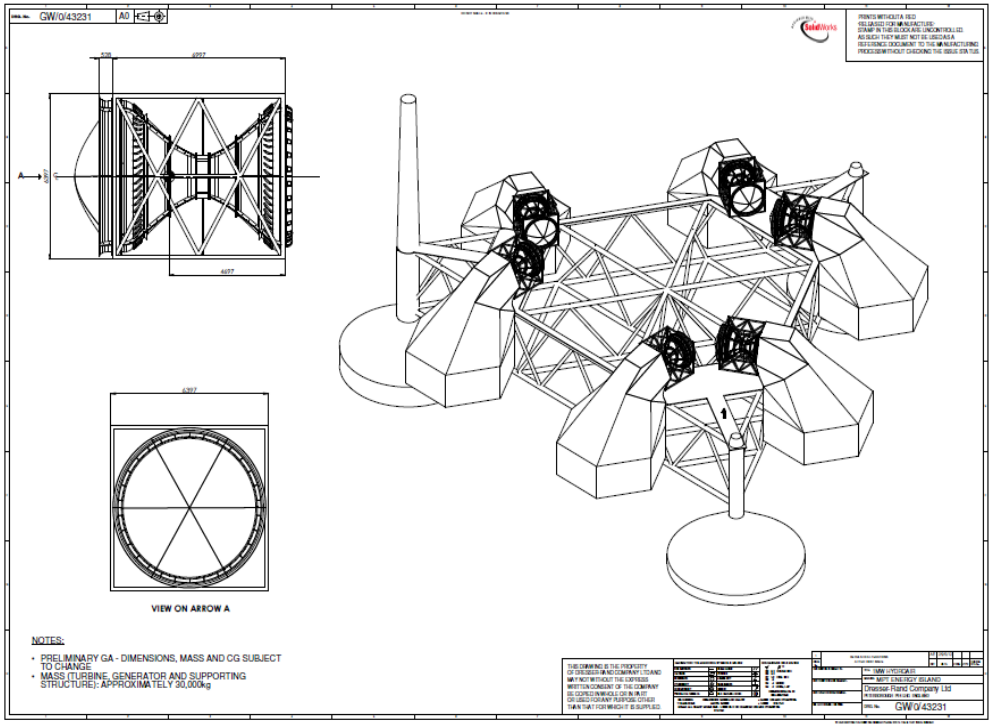
GRS Scope

Power Platform – Technology testing steps



Physical & Numerical
Established a comprehensive testing plan for both numerical and physical assessments.

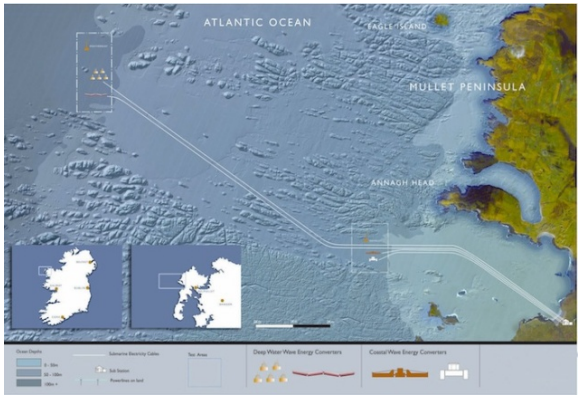
1.Tank Testing: HMRC expertise in wave energy tank testing. Developing results in a stage gate process to allow third party validation.

2. Numerical: WaveC carried out a detailed study based on a WAMIT model.

3. Conclusion: Results comparison

Site Requirements – Design Point

Hs	Tp 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
0.5	0.00	0.56	3.48	1.64	2.32	2.03	2.64	2.14	1.85	0.76	0.27	0.37	0.30	0.04	0.11	0.02	0.06	19.5%
1	0.00	0.09	1.35	0.90	1.56	1.66	1.71	1.82	1.63	1.09	0.38	0.45	0.38	0.03	0.19	0.03	0.05	14.0%
1.5	0.00	0.00	0.18	0.59	1.62	1.48	2.11	3.48	3.66	2.55	1.03	0.75	0.92	0.00	0.20	0.01	0.12	19.6%
2	0.00	0.00	0.00	0.30	0.59	0.53	0.58	0.60	1.16	3.35	1.57	1.05	0.32	0.00	0.09	0.00	0.04	10.7%
2.5	0.00	0.00	0.00	0.00	0.52	0.57	0.75	0.80	1.43	1.70	0.90	0.71	1.01	0.00	0.29	0.00	0.09	9.2%
3	0.00	0.00	0.00	0.00	0.06	0.19	0.35	0.53	0.59	1.33	2.49	0.70	2.03	0.00	0.31	0.00	0.07	9.1%
3.5	0.00	0.00	0.00	0.00	0.00	0.13	0.25	0.28	0.32	0.41	0.88	0.98	1.14	0.00	0.33	0.00	0.07	5.0%
4	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.15	0.15	0.26	0.73	0.28	2.25	0.00	0.72	0.00	0.19	5.1%
4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.05	0.11	0.01	0.59	0.00	0.40	0.00	0.05	1.3%
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.03	0.08	0.48	0.95	0.00	0.63	0.00	0.37	2.8%
5.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.09	0.14	0.00	0.56	0.00	0.10	0.00	0.20	1.2%
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.22	0.00	0.07	0.00	0.00	0.4%
6.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.11	0.00	0.40	0.00	0.41	1.0%
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.20	0.00	0.02	0.4%
7.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.07	0.00	0.20	0.3%
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.14	0.2%
8.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.05	0.1%
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.0%
Total	0%	1%	5%	4%	7%	7%	9%	10%	11%	12%	9%	6%	12%	0%	4%	0%	2%	95

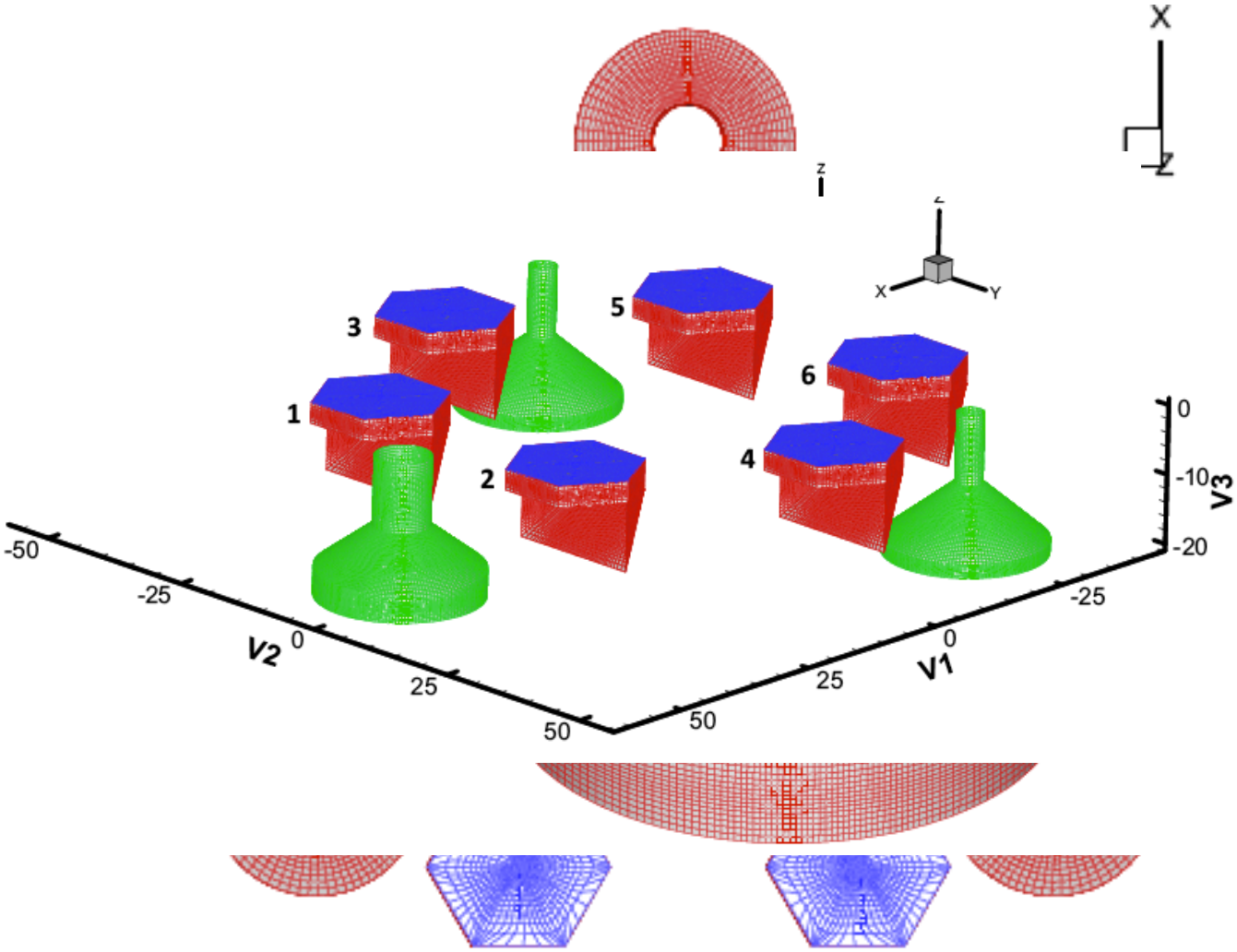


WAMIT: Using the 3D numerical-diffraction model. The main outcomes are the hydrodynamic coefficients of added mass and damping along with the complex amplitude of excitation force.

Both testing programs were carried out in a detailed panchromatic and monochromatic wave environment with similar objectives in an effort to assess results.

The concept was assessed matching it to a specific site location (Scatter Diagram), Belmullet, Co. Mayo, Ireland.

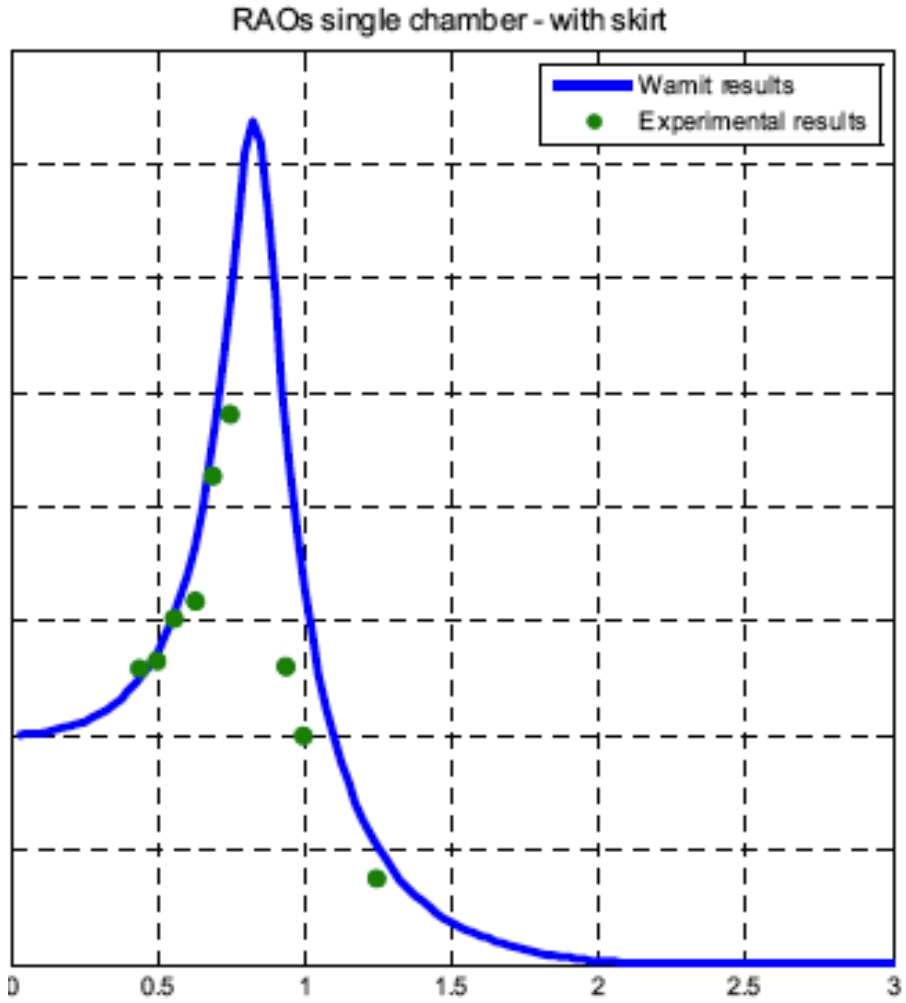
WAMIT Testing



Using the mesh design, GRS was able to gain an understanding of the efficiency of the design. With cost reduction in assessing alternative layouts (skirt).

Adapting turbine specifications to the model enabled us to feed information directly into the economic model.

Results comparison



The results were compared using Response Amplitude Operators (which basically give the ratio of the vertical excursion of the internal free surface and the amplitude of the incoming wave)

Fit between numerical and physical very good and with 5% margin error throughout both tests.

Conclusion: WaveC model now allows GRS to adapt testing results to alternative scatter diagrams.

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