Mechanical testing of large-scale blade prototype and demo installation

1. **Magallanes Renovables**
2. **Blade installation manoeuvre demo**
3. **Tug test. Cp – TSR- Θ curves validation**
4. **Tidal site test – Turbine balancing.**

Javier Grande – Bilbao 2023

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Magallanes Renovables. Philosophy

Use existing technology developed by already mature industries, minimizing the technology risk, securing success.

Modular construction	*Reduces CAPEX and easies mass production*
Floating platform	*Eases maintenance and reduces OPEX*
Variable Pitch	*More Production - LCOE*
Counter-rotating rotors	*Give stability to the platform*
Double mooring	*Being anchored at both ends Creates a safe environment*

Nominal Power = **1,5MW**

Length = **45m**

Beam = **6m**

Max. Draft = **22m**

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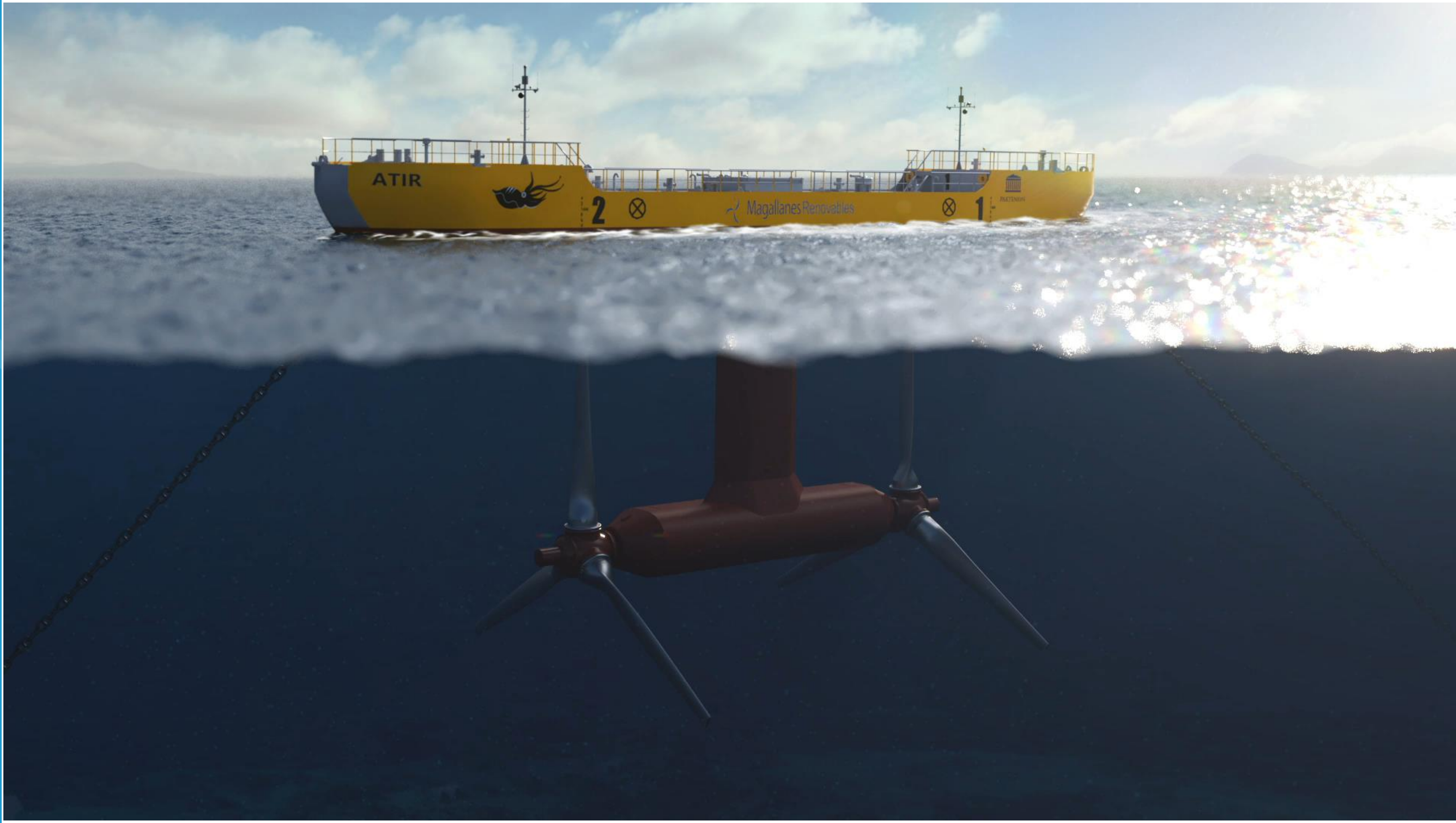
Magallanes Renovables. The ATIR



Magallanes Nemmo objectives

1. Blade installation manoeuvre demo:

Blade should be installed and replaced at sea, by divers in an underwater manoeuvre.

Original blade needs a hard tool to handle and ballast it to be installed at sea. 6 blades installation in 5 days.

New blades solve these issues, we hope to install 6 blades in 1 day.

2. Tug test. Cp – TSR- Θ curves validation

Towing tests are carried out to solve problems before installing in tidal zone.

3. Tidal site test – Turbine balancing.

Final test in tidal site are performed to final setup of the device and its control system.

Blade ageing and bio-fouling growth will be also monitored

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Blade installation manoeuvre demo

Blade is transported by multicat boat in horizontal position, for installation the blade is turning and launching by crane.

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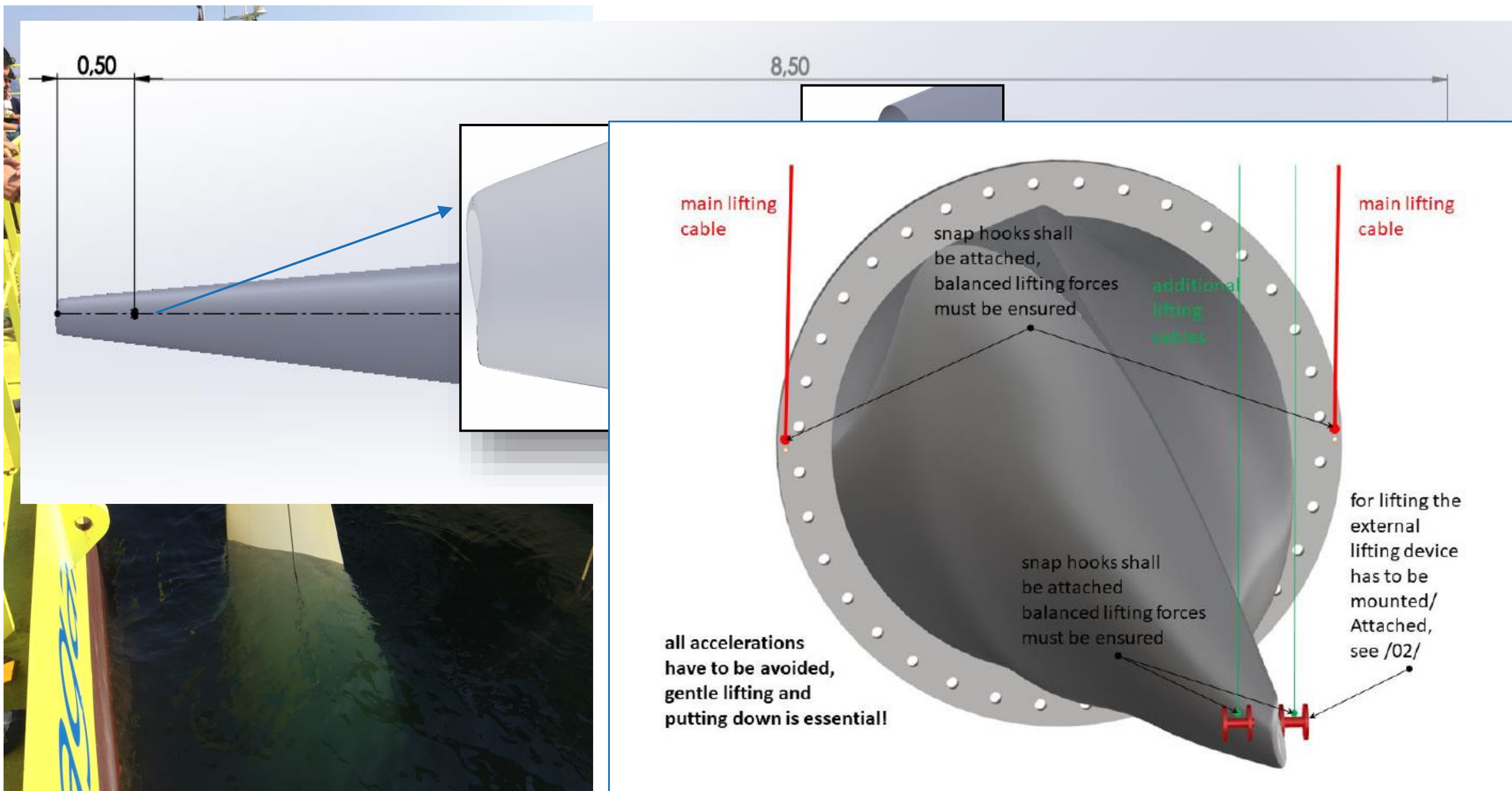
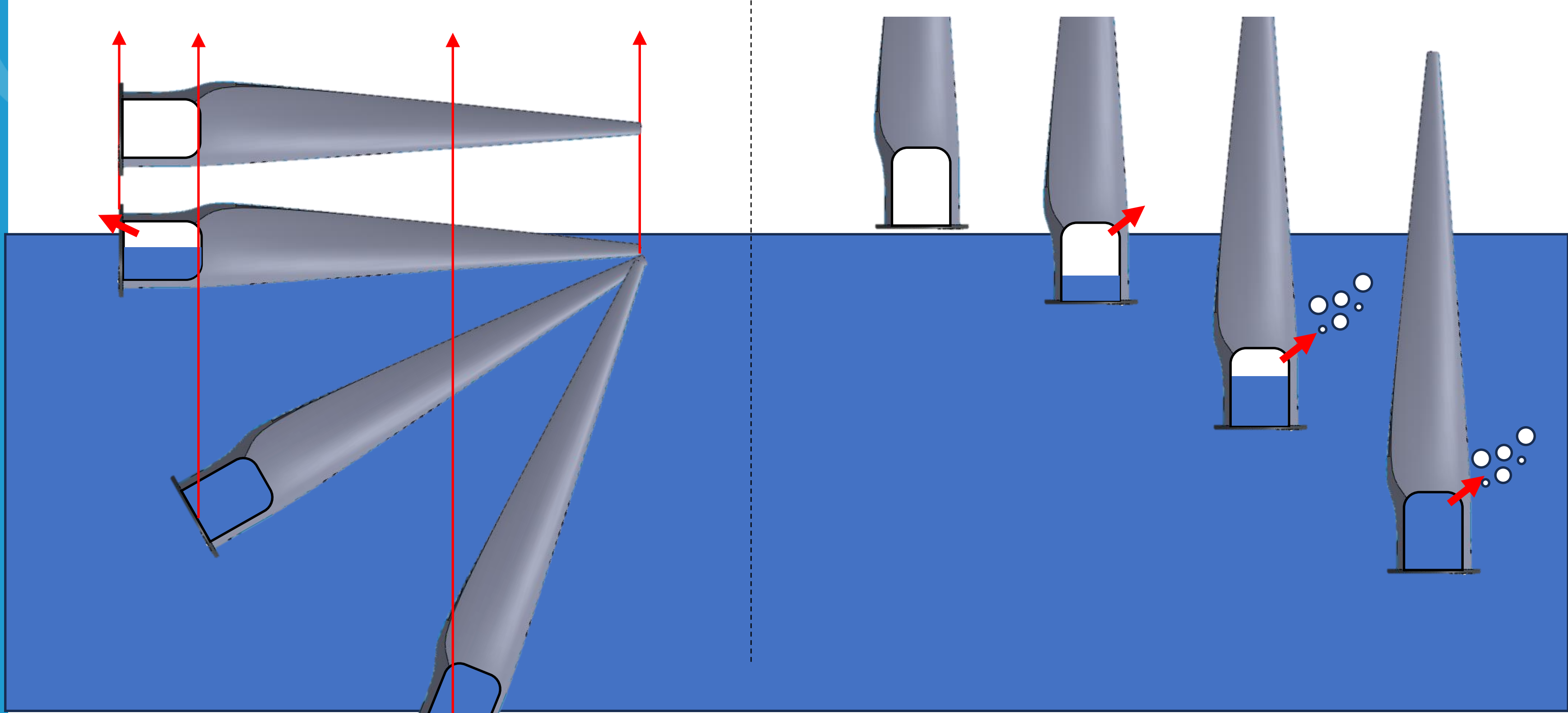
Blade installation manoeuvre demo

Lifting point is machined near the tip to lift and handle the blade. This avoids having to use other blade handling tools that could damage it.



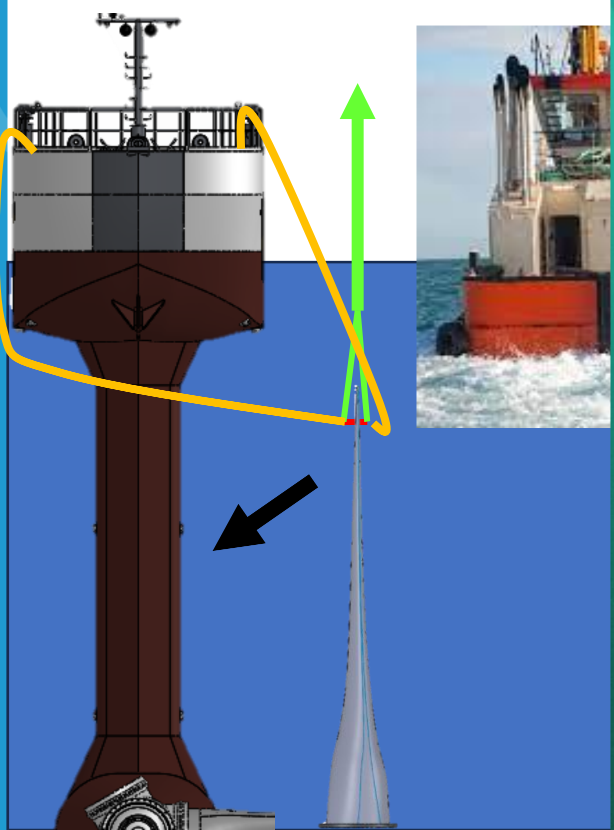
Blade installation manoeuvre demo

The buoyancy of the blade is a problem for its underwater handling, so this blade has a cavity that will be filled with water to achieve neutrality buoyancy and make easier the installation



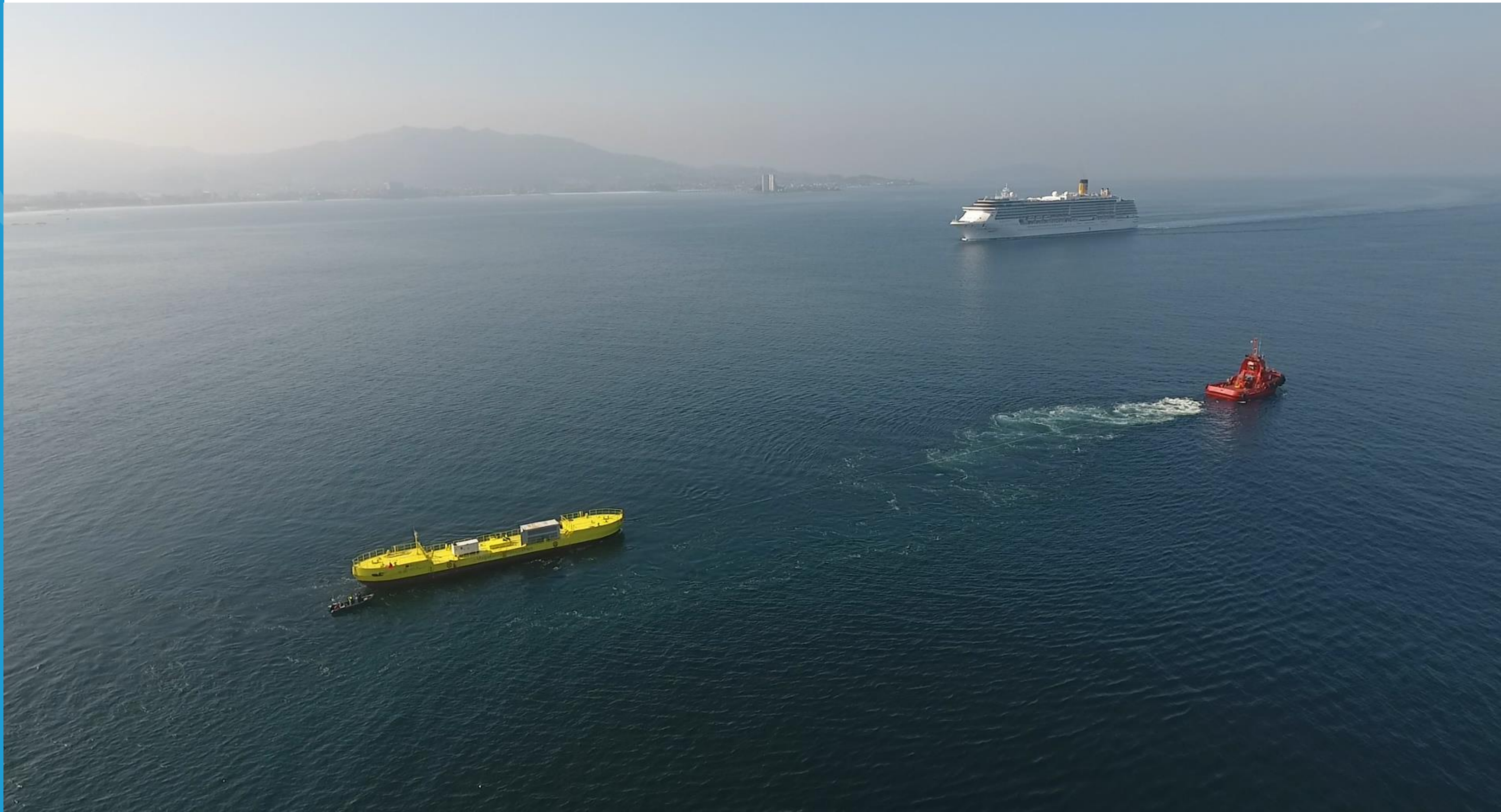
Blade installation manoeuvre demo

Once in the water, the handling point changes from the crane to the ATIR. Guide wires are used to positioning the blade in the hub.



Towing test – General arrangement

Tugboat pull the ATIR producing relative speed on the turbines. Power: 400kW maximum.

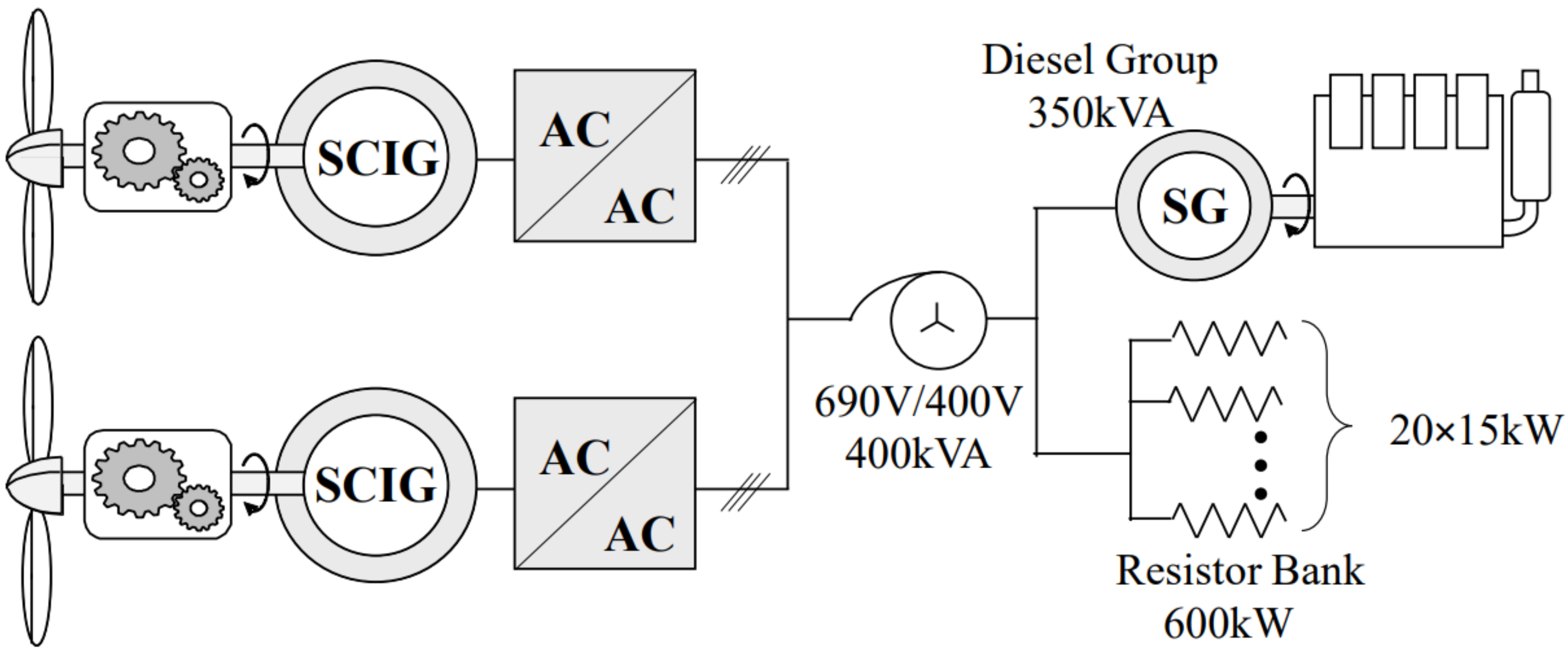


Tug test – General arrangement

The power grid is emulated using an autotransformer, a diesel generator, and a bank of load resistors.

Tug test – General arrangement

The power grid was emulated using an autotransformer, a diesel generator, and a bank of dump load resistors.

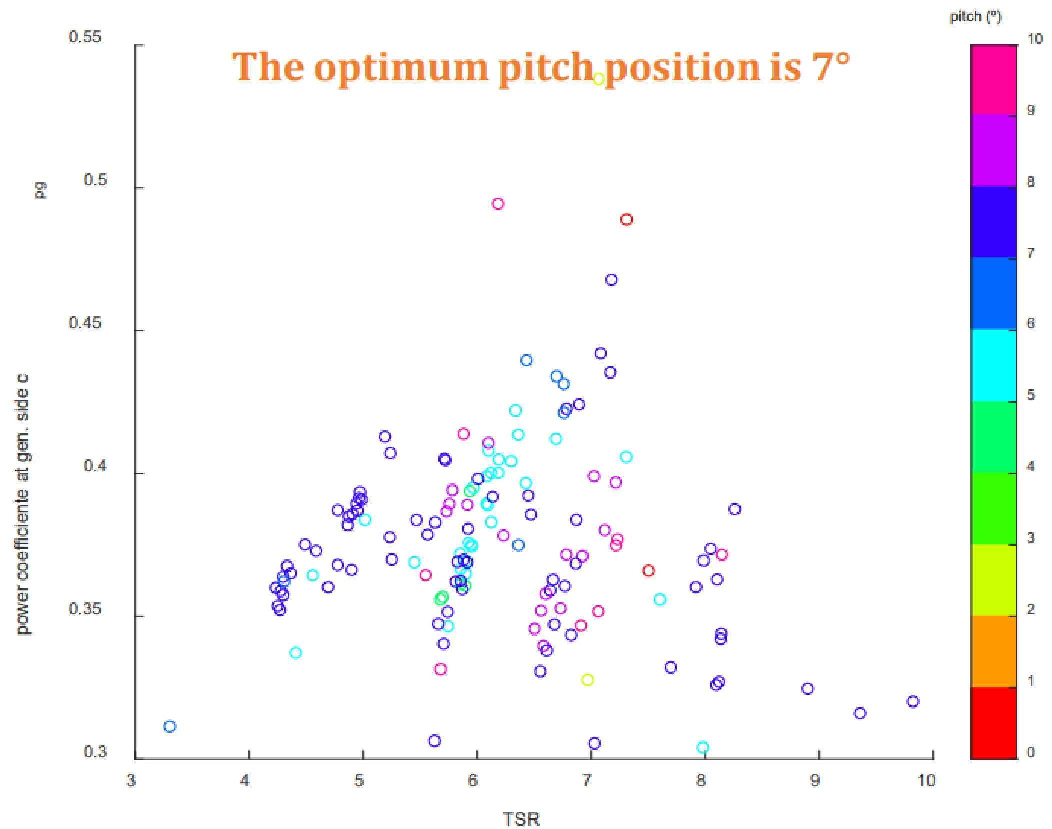


Tug test – Testing process

The tests are carried out by gradually varying the resistive torque in the generator with a constant pitch.

$$c_{pr} = \frac{P_{gen}}{\frac{1}{2}Av^3}$$ **Power coefficient** at generator side

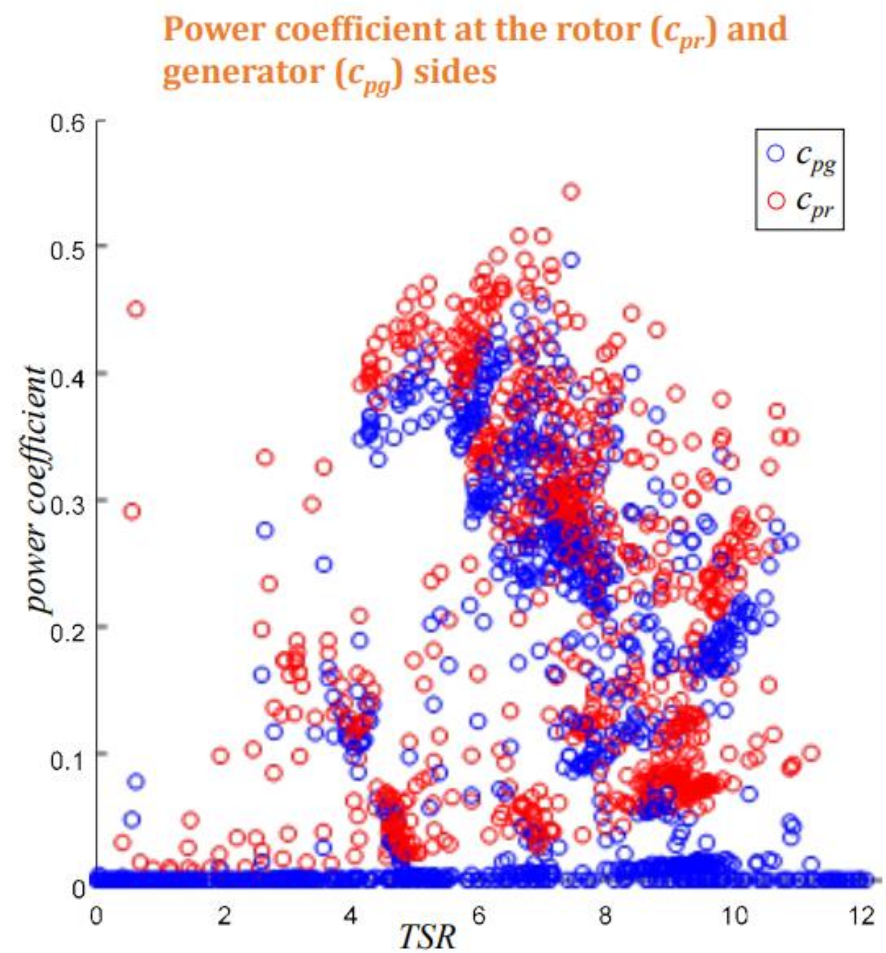
$$TSR = \frac{\omega R}{v_\infty}$$ **Tip Speed Ratio**



Tug test – Testing process

The tugboat varies its speed between 1.5m/s and 3m/s. Power output and turbine speed are measured.

Powertrain losses are taken into account to calculate the turbine Cp.



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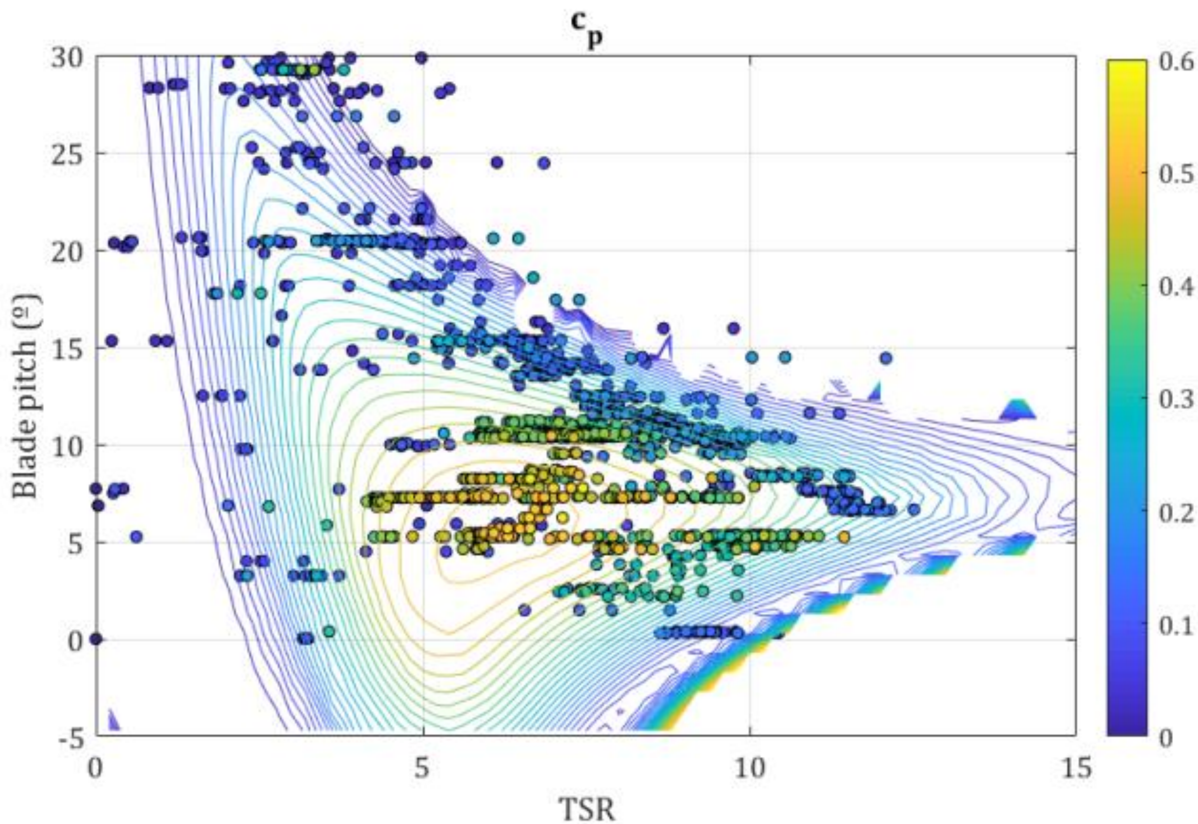
Tug test – Testing process

The real points taken allow us to validate the theoretical model of the turbine

Values of c_{pr} as a function of the TSR and blade pitch



Tidal site test

Same test as tow-test, but nominal power can be reached. Greater than 1MW.

Main objective is to obtain data of the two turbines operating together.

Tidal site test

The control system parameters are set to guarantee balanced generation of both turbines.

Tidal site test

Blade ageing and bio-fouling growth will be also monitored

Thanks!