Pelamis update

Max Carcas, Business Development Director

The challenge

To produce electricity with the lowest p/kWh and deliver attractive returns to our customers/ project investors within the market mechanisms available in different countries

Three key elements:

- Maximise ratio of energy capture : capital cost
  - *Fundamental to Pelamis design concept*
  - *Volume production to reduce capital cost and ongoing supply chain development*
- Minimise costs of insurance, site leases, finance, proportion of fixed costs in a project
  - *Through continued experience and increasing scale*
- Minimise costs of Operation and Maintenance
  - *Through design and methodology in relation to environment and operation*

- This presentation will concentrate on this last aspect

Minimising O&M costs

Three obvious needs:

- Maximise reliability
  - Through use of standard components from established suppliers
  - Condition monitoring
  - Good QA
- Increase fault tolerance
  - Ensure effect of single component failures is minimised through FMECA and good engineering practice
- Ensure machines are cheap and easy to fix
  - High accessibility
  - Fast turn around
  - Design out high cost vessels for routine work

- This presentation will concentrate on this last aspect

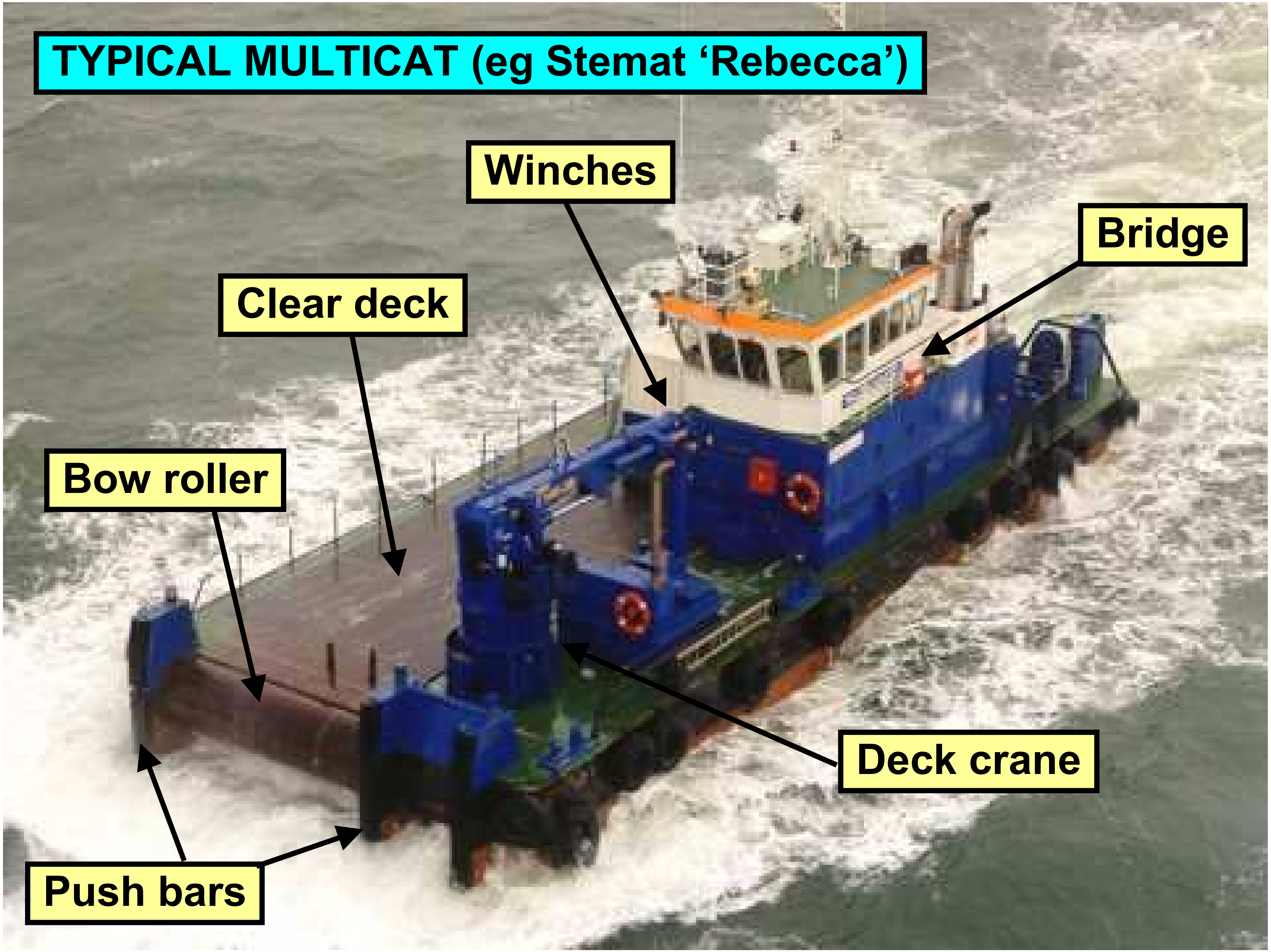
PWP operations experience

- Initial vessel utilised – anchor handler
- Manual mechanical electrical connection/disconnection on deck – time consuming process
- Anchor handler never intended to be the long term solution but ideal for prototype
- Day rates for AHT vessels increased <u>more than twenty-fold</u>

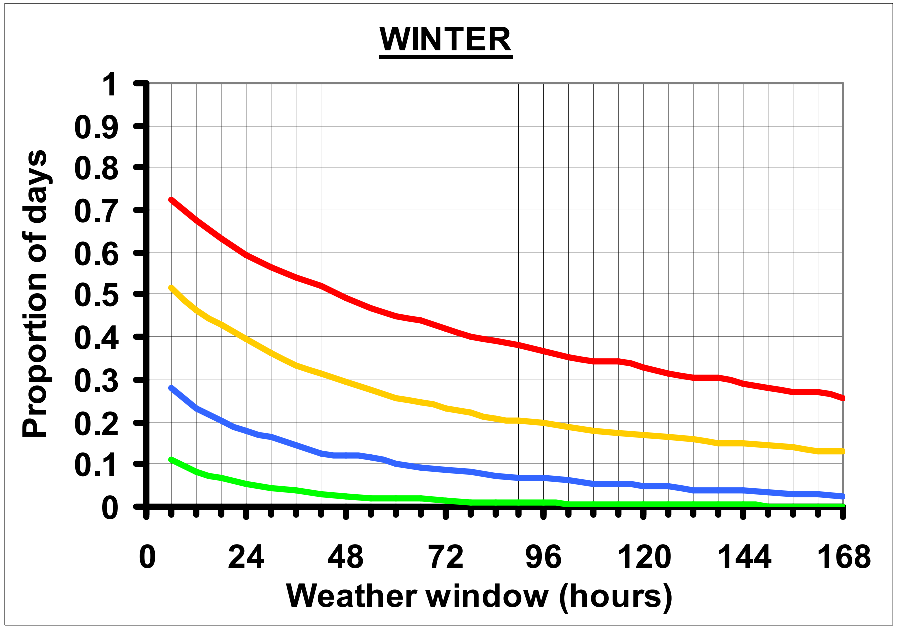
➢ <u>Drive to minimise costs through use of smaller vessels</u>

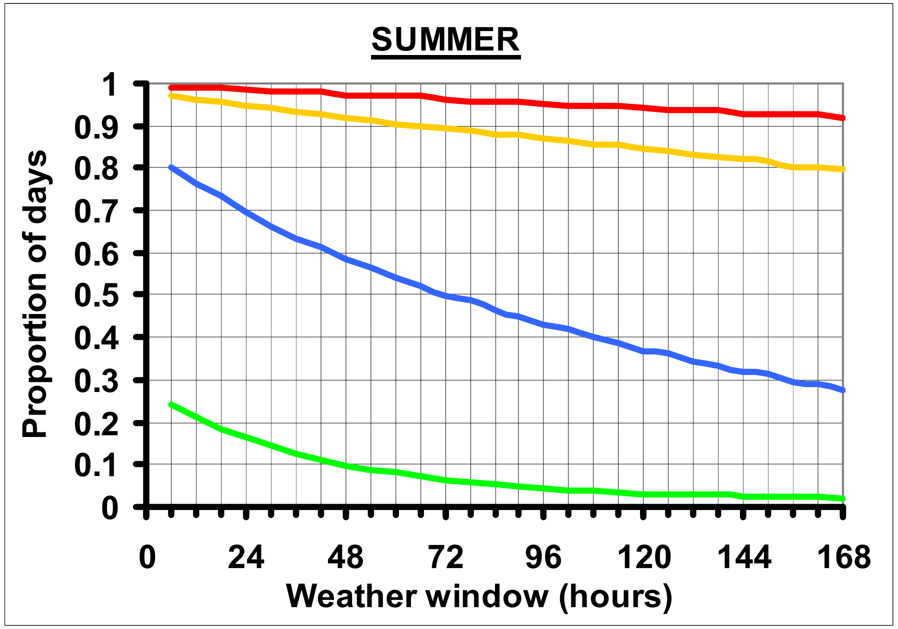
  - Mooring system crucial

Anchor Handler and Multicat


TYPICAL MULTICAT (eg Stemat ‘Rebecca’)
Winches
Bridge
Clear deck
Bow roller
Deck crane
Push bars

Note on weather windows





Probabilities of getting weather windows of given length, for significant wave heights of 4m, 3m, 2m & 1m, for summer & winter seasons.

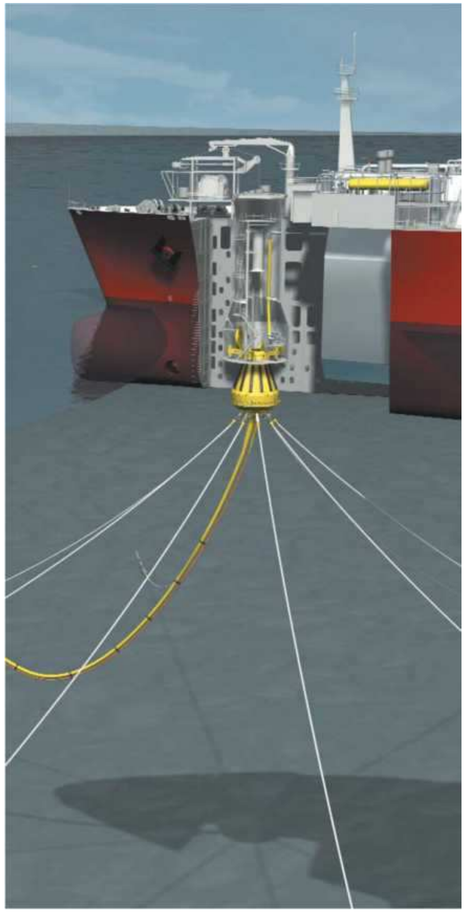
Implications:

- Avoid work out on site wherever possible!
- Intervention times for routine O&M must be short
- Target more weather sensitive initial balance of plant installation work for Summer
- Continue to gain experience and improve methods to extend operational envelope and allow operation in greater wave heights

Example from offshore oil and gas industry

- Submerged Turret Loading (STL) buoy
- Developed in 1990s - current ‘state of the art’

STL Image: APL

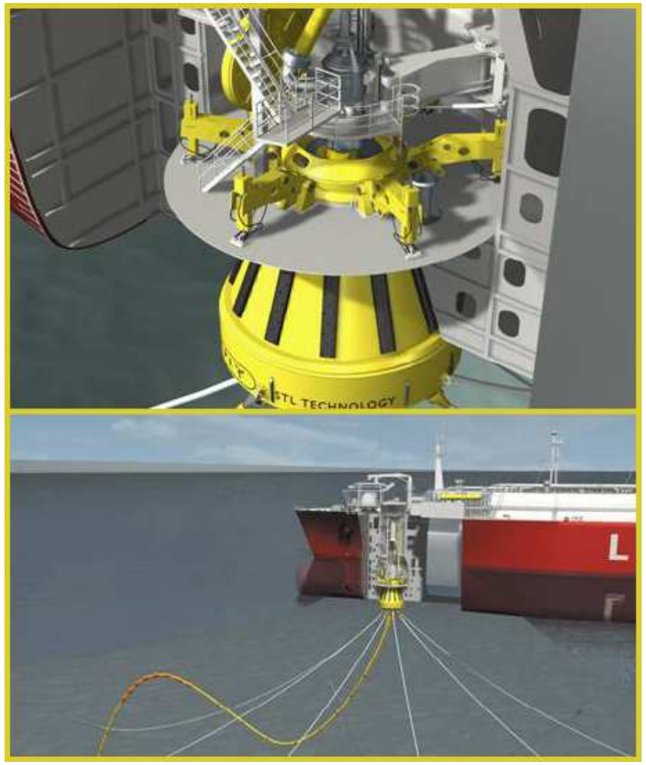


Submerged Turret Loading Buoy

Main design requirements for the STL system:

- Connection in sea states up to 5 - 6 meters
- Weather independent offshore loading
- Disconnect regardless of weather conditions (if required)
- Standardized interface between vessel and STL Buoy (any STL vessel can connect to any STL Buoy)
- Low conversion costs for conventional tankers
- High level of safety
- Minimal risk for oil spills

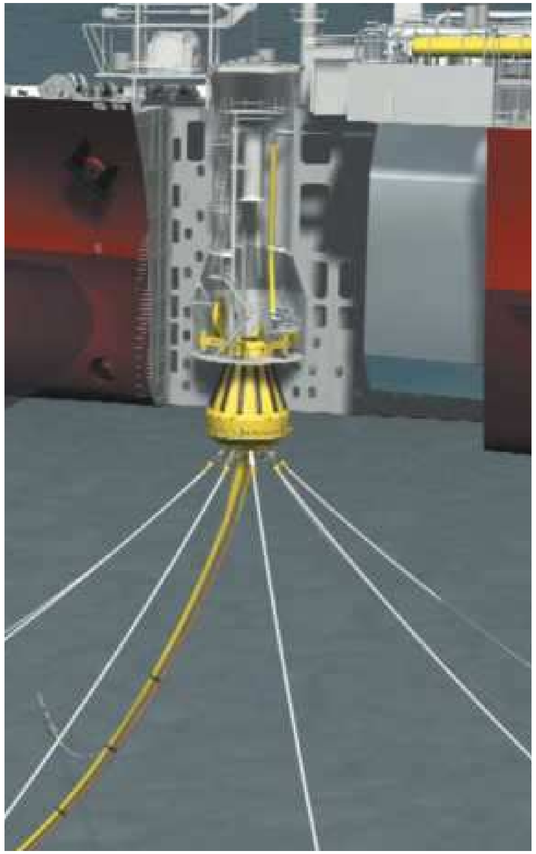
- Cost £10-15m each, order lead time 12-18 months



STL Image: APL

PWP Tether Latch Assembly

- Similar in concept to STL
- Combined mechanical and electrical connection
- No taut lines
- No divers
- No ROVs
- No manned intervention
- All operations carried out remotely
- IP developed and protected by PWP



STL Image: APL

Orkney latch system experience

- Old mooring system removed and new system installed at EMEC 2006
- System in place during winter 2006/7
- First connection to system March 2007 – **worked first time**
- **Proven:** moorings & 6.6kV electrical tieback installation capability
- **Proven:** low-cost machine towing and handling vessels (<£2k/day)
- **Proven:** open water towing demonstrated up to 1.5-2.0m Hs
- **Proven:** 1½ hour machine installation up to 1.5m Hs
- **Proven:** ½ hour machine recovery demonstrated in 2.0-2.5m Hs
- Further testing during 2007 validated approach for Portugal

Portuguese latch system

- Identical to Orkney system – however configuration and conditions slightly different

Problem:

- Gradual loss of buoyancy in foam seen post installation in Q4 2007

Presumed:

- Foam buoyancy not to required specification
- Successful recovery and attachment to can buoys in Winter 2007 to protect the site equipment from damage

Corrective actions

- Detailed review of specifications and QA procedures
- New foam buoyancy ordered from Norwegian suppliers, received December 2007
- Design of recovery skid interfaced to multicat workboat
- Full stability structural analysis in conjunction with vessel manufacturer
- Safe working load (dynamic) >60 tonnes
- Detailed full offshore procedures and health and safety plan in place and approved
- Full Hazard Identification and Risk Assessment (HIRA) completed
- Dry runs in dock
- Conditions defined for recovery of mooring system:

  <1m Hs for >48 hours

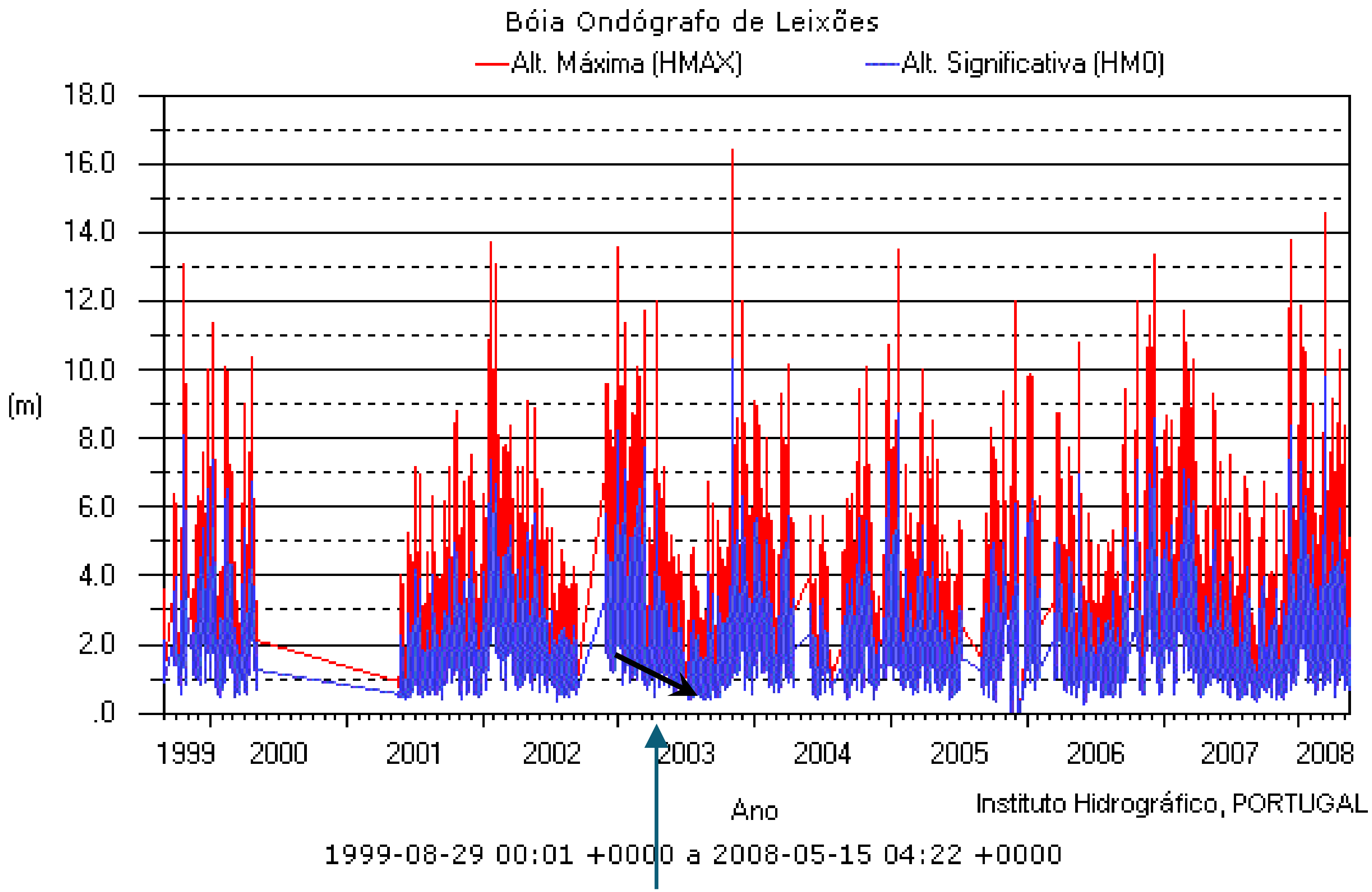
  (ops expected to take 24-26 hours per mooring)

  <15 knots wind
- General philosophy: take no chances on first operation

Recovery skid

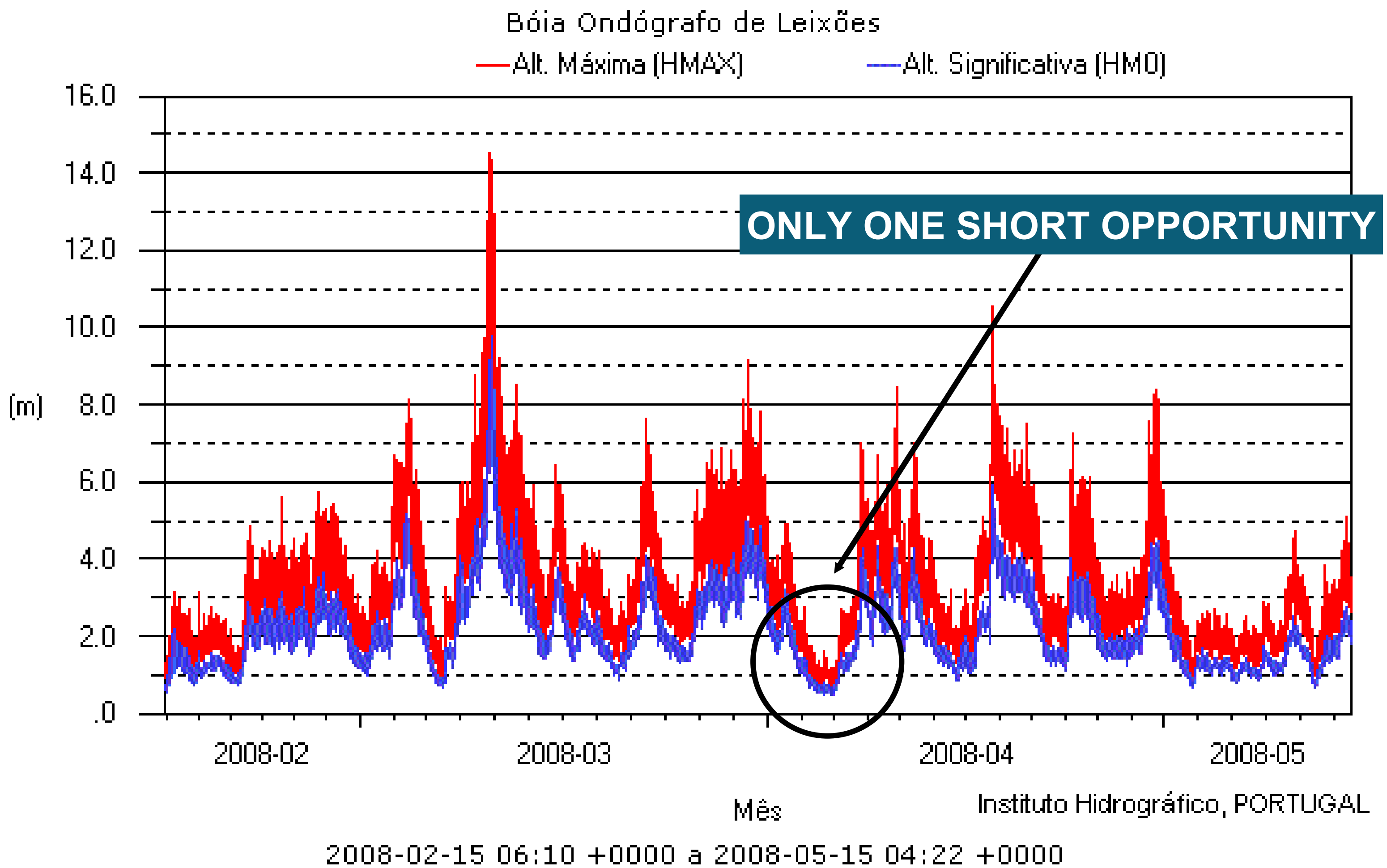
- Health and Safety number one priority
- Potentially hazardous operation
- Important to stress this is an 'abnormal' operation that would not normally be required during project installation or operation

Annual conditions at Leixões



In general increasing probability of Hs <1m from April onwards

2008 conditions at Leixões



Health and Safety review flagged up an issue – more time required

Daily conditions

Média horária

Boia de Leixões com 39 registos entre 2008-05-14 06:00 +0000 e 2008-05-15 10:00 +0000

Data	Hora	Registos	Hs (m)	Hmax (m)	Tz (s)	Tmax (s)	Direcção	Temp.(°C)
2008-05-14	06:00	1	1.81	2.73	6	11.7	WNW	14.9
2008-05-14	07:00	4	1.87	2.72	6.4	12.3	WNW	14.9
2008-05-14	08:00	3	1.87	2.68	6	11.7	WNW	14.9
2008-05-14	09:00	1	2.00	2.71	6	11.7	WNW	14.9
2008-05-14	11:00	1	1.90	2.49	5.5	10.9	WNW	14.9
2008-05-15	02:00	1	1.89	2.64	6.4	11.7	WNW	15.1
2008-05-15	03:00	1	1.87	2.85	6.7	11.7	W	14.9
2008-05-15	04:00	3	1.77	2.57	6.3	12	WNW	14.9
2008-05-15	05:00	4	1.90	2.71	6.1	10.9	WNW	14.9
2008-05-15	06:00	5	1.82	2.64	6.2	11.3	WNW	14.9
2008-05-15	07:00	5	1.77	2.57	6.3	11.8	WNW	14.9
2008-05-15	08:00	4	1.87	2.67	6.4	11.3	WNW	14.9
2008-05-15	09:00	4	1.69	2.73	6.2	11.1	WNW	15
2008-05-15	10:00	2	1.66	2.72	6.1	10.5	WNW	15.1

Data no servidor: 2008-05-15 12:38 +0100

- Weather steadily improving, there will be windows
- Difficult to forecast with confidence >5 day ahead

Machines ready for operation

Deployment phases

Phase 1

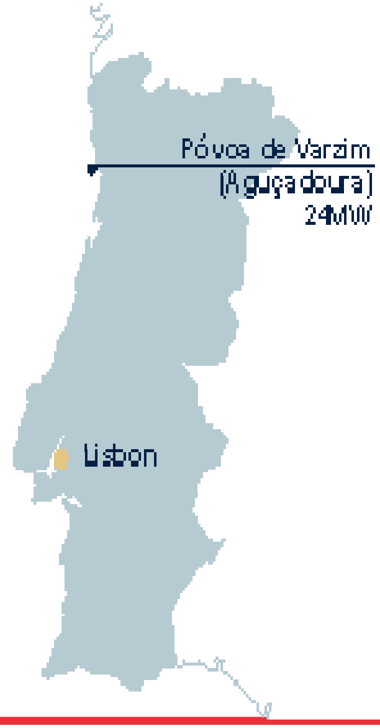
- Three Pelamis P-1A 750kW machines
- Permitting & consents in place
- Substation and submarine cable ready
- Installation Q2 2008

Phase 2 expansion

- Expand project to 20MW
- Survey work completed
- Grid studies completed

Phase 3

- Multiple site roll-out (550MW)
- Significant customer commitment



Supportive and committed customer

FINANCIAL TIMES

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Nigeria's middle class Page 10

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Making waves with new power generation technology

CASE STUDY

Harnessing the sea's energy is making the country a leader in the field, writes **Peter Wise**

Surfing the wave: power from the Atlantic

A string of three red steel tubes, each the size of a railway carriage, lies low in the water off the northern coast of Portugal.

As the snub-nosed apparatus rises and dips in the Atlantic waves, it becomes immediately clear why this pioneering energy technology is called Pelamis after a mythical giant sea snake.

Later this year, these wave energy converters, developed over many years of testing by Edinburgh-based Pelamis Wave Power, will be pumping electricity into Portugal's national grid, making it the first country in the world to harness wave energy on a commercial basis.

"Portugal has the opportunity to do for wave power what Denmark has done for wind energy," says Ian Sharpe of Australia's Babcock & Brown, the leading partner in the project through Enersis, its Portuguese renewable energy company.

In two years, 23 of these converters, moored to the seabed about seven kilometres off the coast south of Porto, should be in operation, with a total capacity of 22.5MW. But Enersis has its sights on a more ambitious project involving an investment of up to €1.5bn in Portuguese wave energy farms with a total capacity of 500MW, enough to power 450,000 homes.

"Scale is essential to reduce manufacturing and operational costs," says Mr Sharpe, a member of Babcock & Brown's European infrastructure team. "At 500MW, we envisage wave energy will begin to converge with wind power in terms of cost per kilowatt-hour."

The Lisbon government's decision to embrace wave power is partly aimed at creating an industry "cluster", including a manufacturing base for wave energy converters and related equipment. In this way, it hopes to gain first mover's advantage in establishing the country as an international centre of know-how for an emerging technology.

Part of Portugal's attraction for Babcock & Brown is its policy of paying renewable energy producers feed-in tariffs, an incentive that guarantees the sale of all the power they produce at stable prices above the rates paid for electricity produced from fossil fuels.

"This is a much better approach that the systems used in many other countries, including the US and the UK," says Mr Sharpe.

Portugal has also designated a special maritime zone for pilot wave power projects and will ensure transmission capacity on the national grid. The measures are designed as extra incentives in addition to the country's natural advantages for tapping wave energy.

Besides the huge energy potential of the waves that crash into Europe's western-most shore, all Portugal's big population centres are located along the coast, reducing the cost of transmitting electricity from offshore wave farms to end users. Officials estimate wave power could eventually supply 20 per cent of the country's electricity needs.

> Portugal has the opportunity to do for wave power what Denmark has done for wind energy

"This is a real opportunity for Portugal and the government is clearly committed to making it happen," says Mr Sharpe.

"Denmark became a manufacturing hub for wind turbines by promoting wind energy more than any other country. Portugal can do the same for wave power."

Enersis's interest in wave energy began several years before 2005, when Babcock & Brown acquired 100 per cent of the company from Semapa, a Portuguese cement group, for an enterprise value of €1.3bn. It had already built a seabed cable in preparation for transmitting wave farm energy to the national grid.

After early trials with other prototypes, Enersis established a partnership with Pelamis Wave Power, whose technology is widely acknowledged to be most advanced in terms of commercial energy production. Enersis owns 70 per cent of its Portuguese joint venture with the Scottish company.

In addition to its groundbreaking wave energy project, Enersis's wind farm portfolio in Portugal and France is expected to reach a capacity of 1,000MW next year, up from 170MW when it was acquired by Babcock & Brown.

Although Pelamis Wave Power engineers have tested their wave converter system off the Orkneys, Scotland does not yet have the transmission capacity in the required locations to make a commercial project viable.

But Portugal is committed to investing in this transmission capacity and, in four to five years, should be benefiting from large-scale commercial wave energy production.

In the Pelamis system, energy is created as waves cause the hinged joints of the semi-submerged steel cylinders to move, pumping high-pressure oil through hydraulic motors that drive electricity generators.

Power from these joints is fed down a single "umbilical cord" to a junction on the seabed. Several devices can be linked together and connected to the shore through a single cable.

"Wave as an energy resource is similar to wind, but we think it will be more stable," says Mr Sharpe. Some renewable energy specialists believe wave farms in Portugal could yield up to three times as much power as wind farms for the same investment cost.

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pelamis wave power