

Hydrokinetic Technologies Technical and Environmental Issues Workshop

the Wave Dragon case

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Regions where wave energy is most feasible



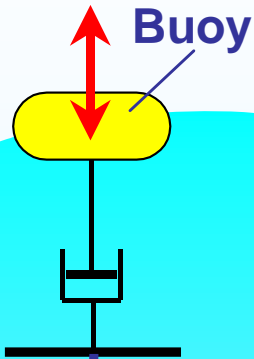
---  --- The western wind belt with the wave energy density in kW/m ---

Wave Energy Conversion Techniques

Heaving Devices



Wave Direction



Seabed

Rambøll, Denmark
 1:10 tests in open sea, 1:4
 scale model (2.5 m diameter)
 OPT, USA, 2004

Teamwork Technology BV,
 The Netherlands
 2 MW pilot plant deployed
 2004 in Portugal

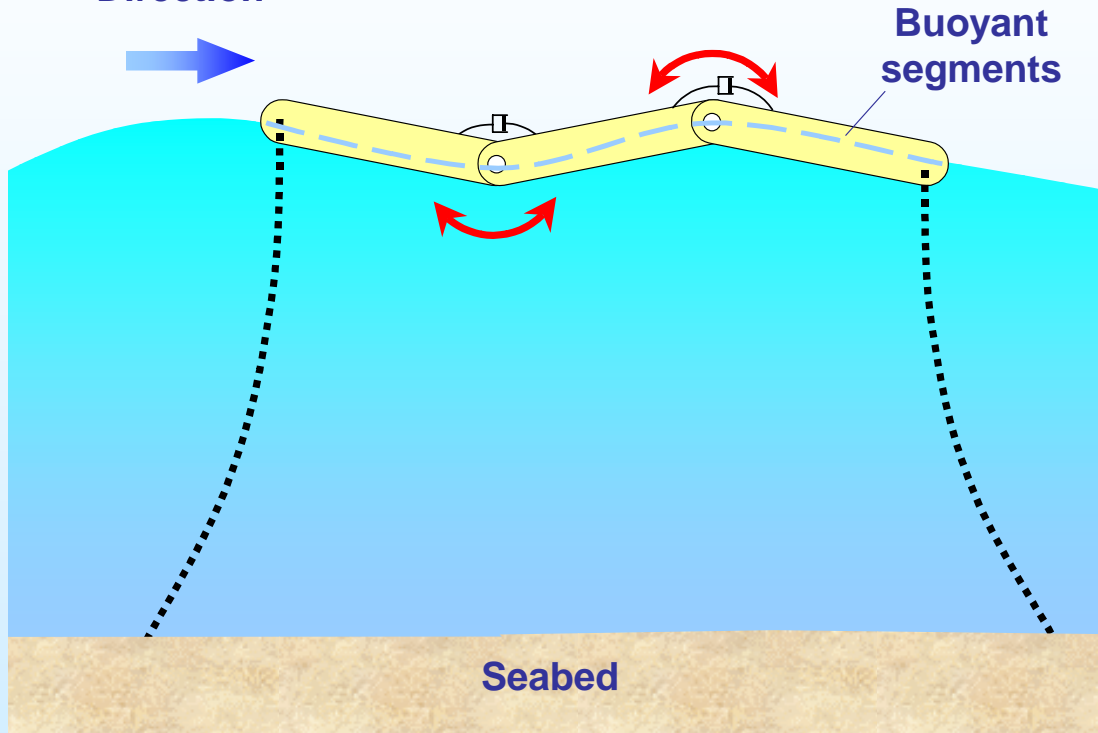


Wave Energy Conversion Techniques

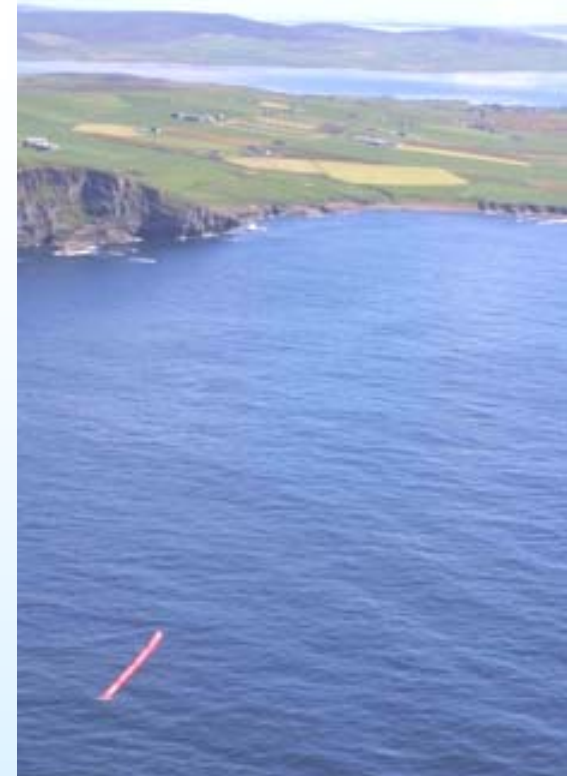
Pitching Devices



Wave
Direction

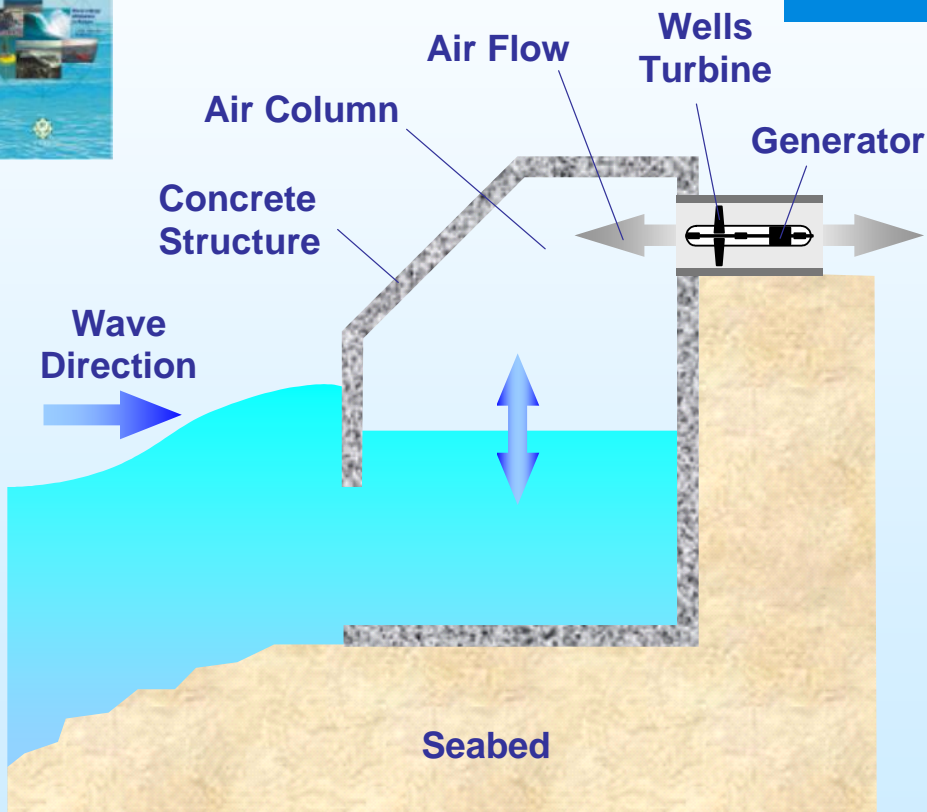
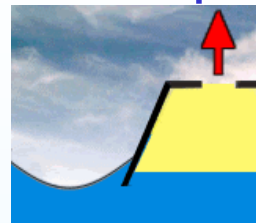


Pelamis, Ocean Power Delivery Ltd (OPD), Scotland
 Tank tests in small scales (1:80, 1:35, 1:20)
 Open sea tests 1:7 (2001), 1:1 (2004), 750 kW scheme



Wave Energy Conversion Techniques

Oscillating Water Column



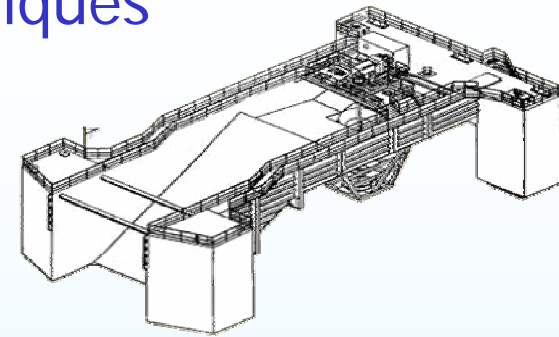
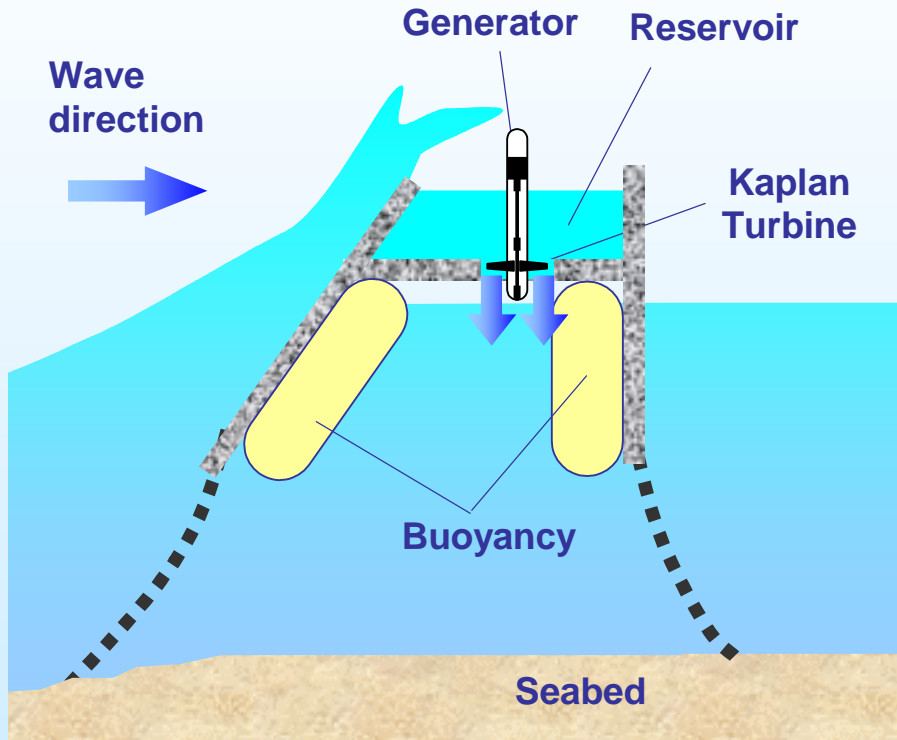
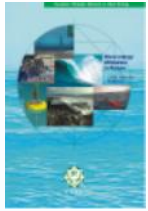
500 kW shoreline OWC (2000)
Islay (Scotland)



400 kW (1998), Pico Island (Azores)
Fully automated, full-scale testing facility

Wave Energy Conversion Techniques

Overtopping Devices



Pilot plant deployed in '80s Sweden,
Sea Power Intl.,
15-year contract for 1.5 MW, Shetland.



Pilot plant 1:4½ deployed 2003 Denmark,
Wave Dragon ApS,
Prototype 1:1 planned by 2005 Wales, UK.

Tapchan, Norway



Islay 70 kW



Trivandrum, India

SDE, Israel



Sakata Breakwater, Japan



Flap Device, Japan



Takenaka, Japan



OSPREE

Fixed wave energy devices



SeaPower



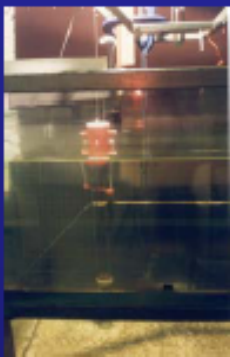
DWP



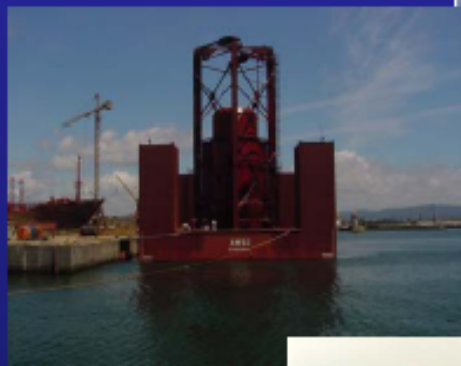
Wave Dragon



Pelamis



IPS Buoy



AWS



Sperbuoy



Mighty Whale



McCabe WP



Kaimei

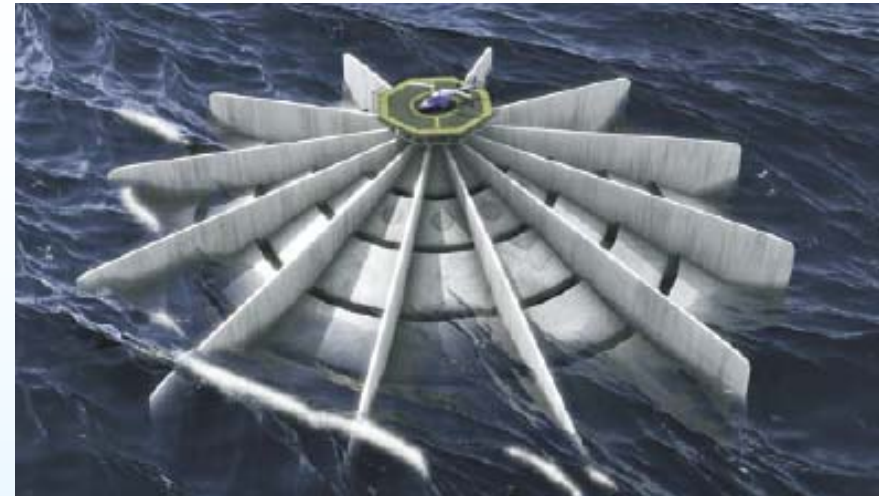
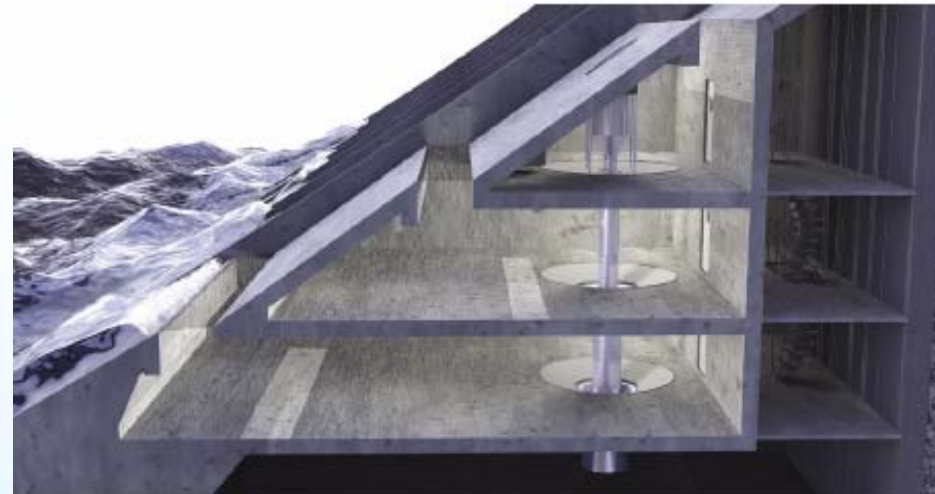


WavePlane

Floating wave energy devices



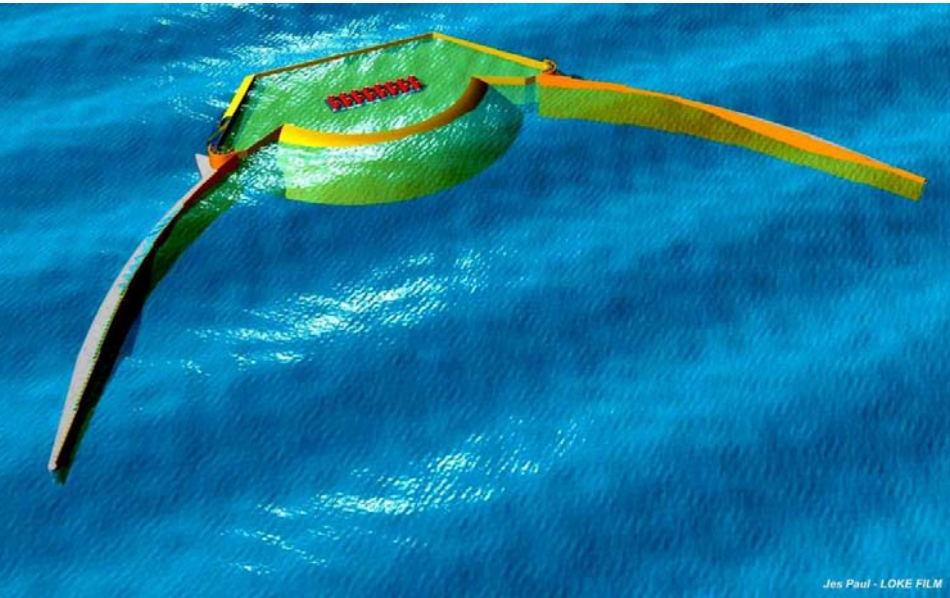
Tapchan



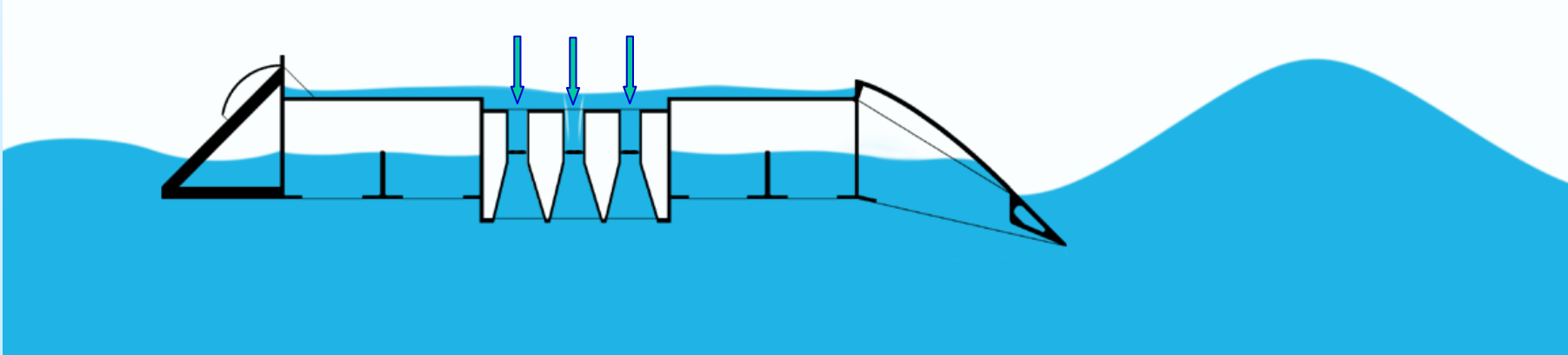
SSG (Seawave Slot Cone Generator)

Wave Dragon principle

The Wave Dragon is a slack-moored wave energy converter that can be deployed alone or in parks wherever a sufficient wave climate and a water depth of more than 20 m is found.

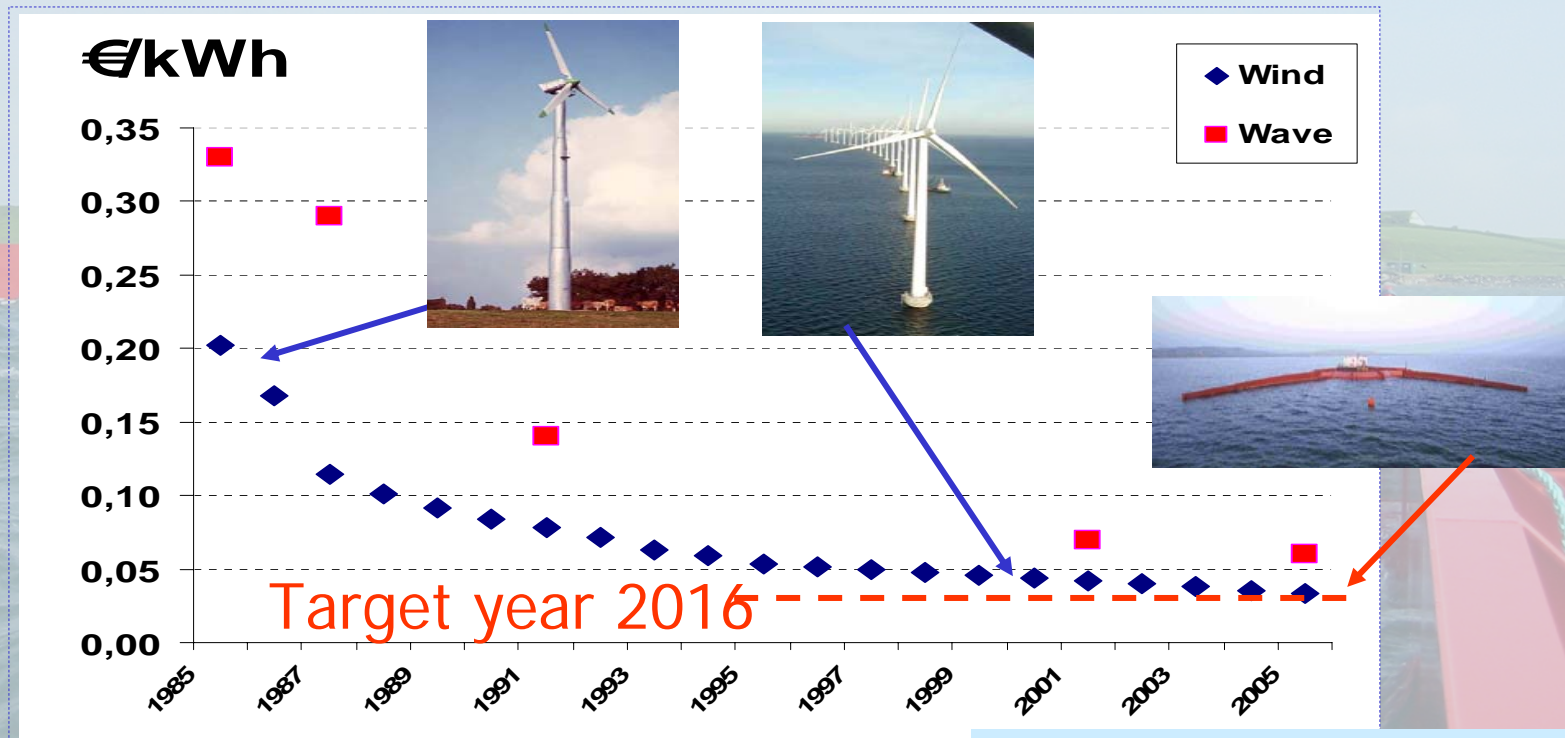


<u>Climate</u>	<u>Power production</u>
24 kW/m	12 GWh/y/unit
36 kW/m	20 GWh/y/unit
48 kW/m	35 GWh/y/unit



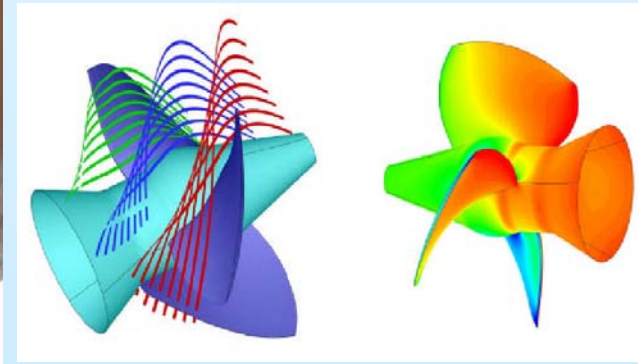
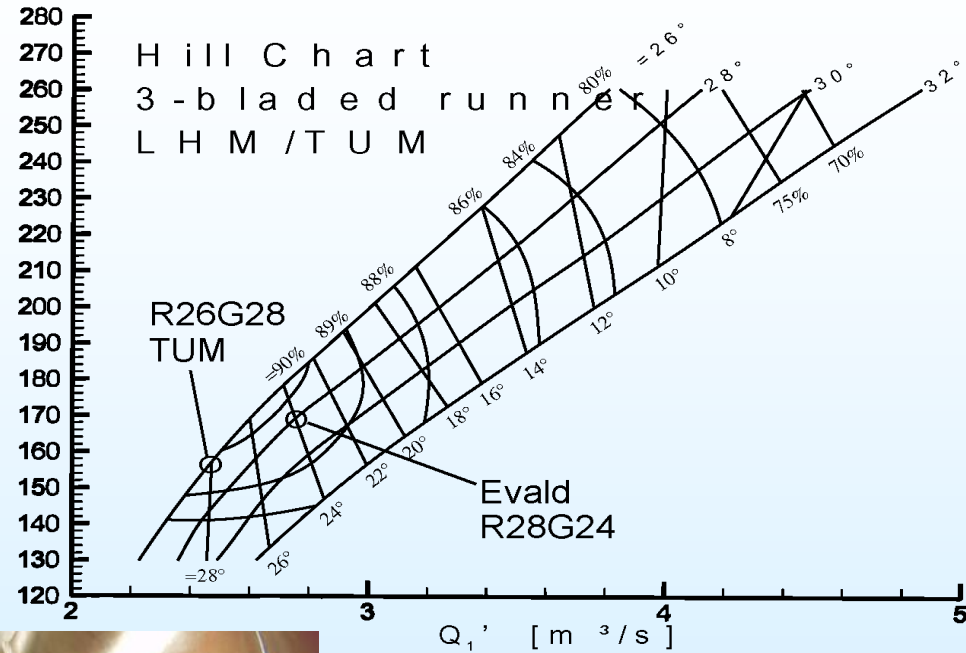
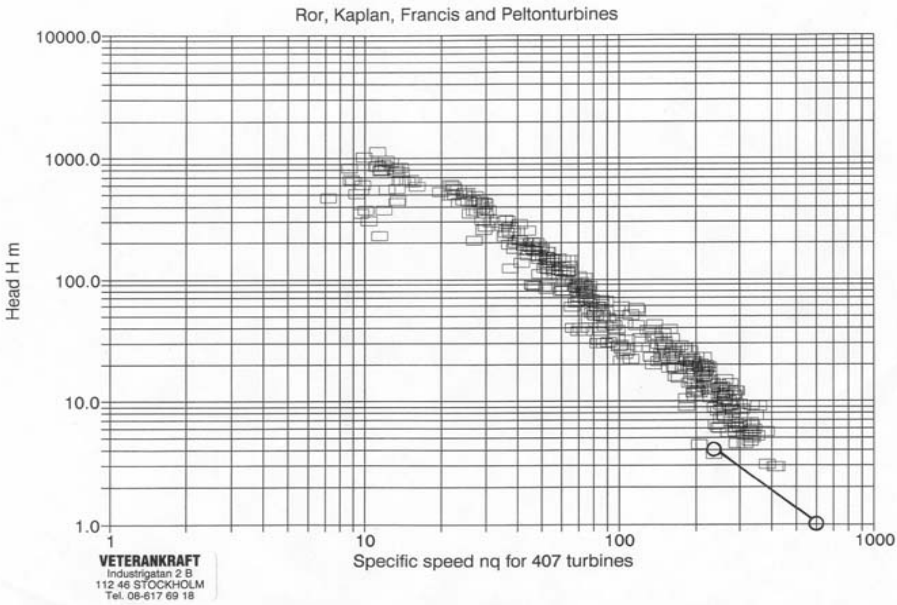
Wave Dragon objectives

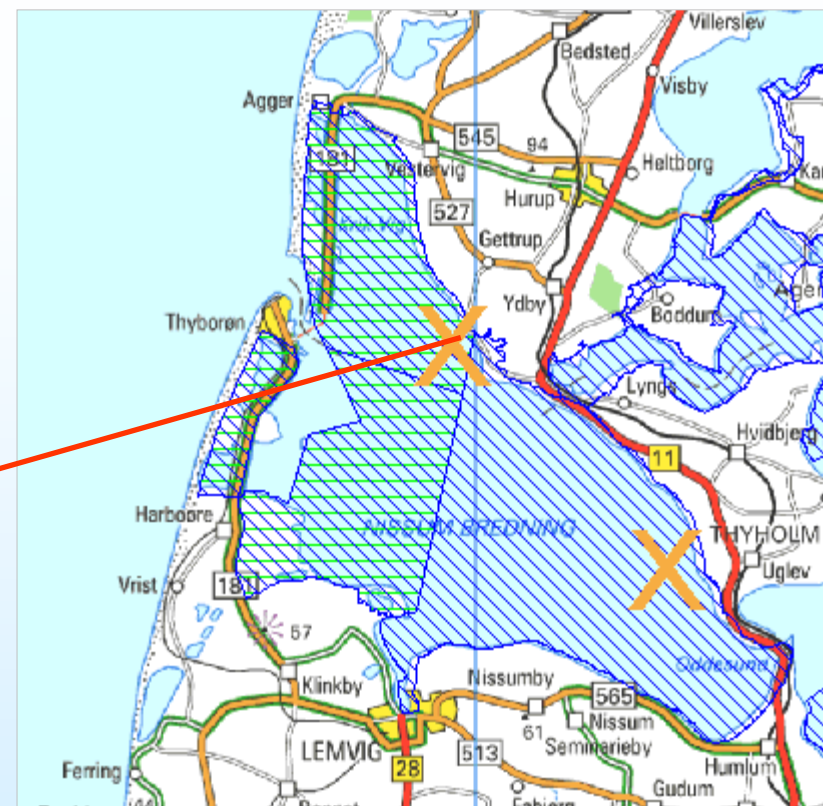
To develop Wave Dragon to a power plant unit of 4 to 11 MW with a production price of 0.04 €/kWh



Source:
EU Wave Net 2002 and Risø

WD turbine Ø 340mm runner has been tested.
 The efficiency is very high (>90%) and the noise level is very low.

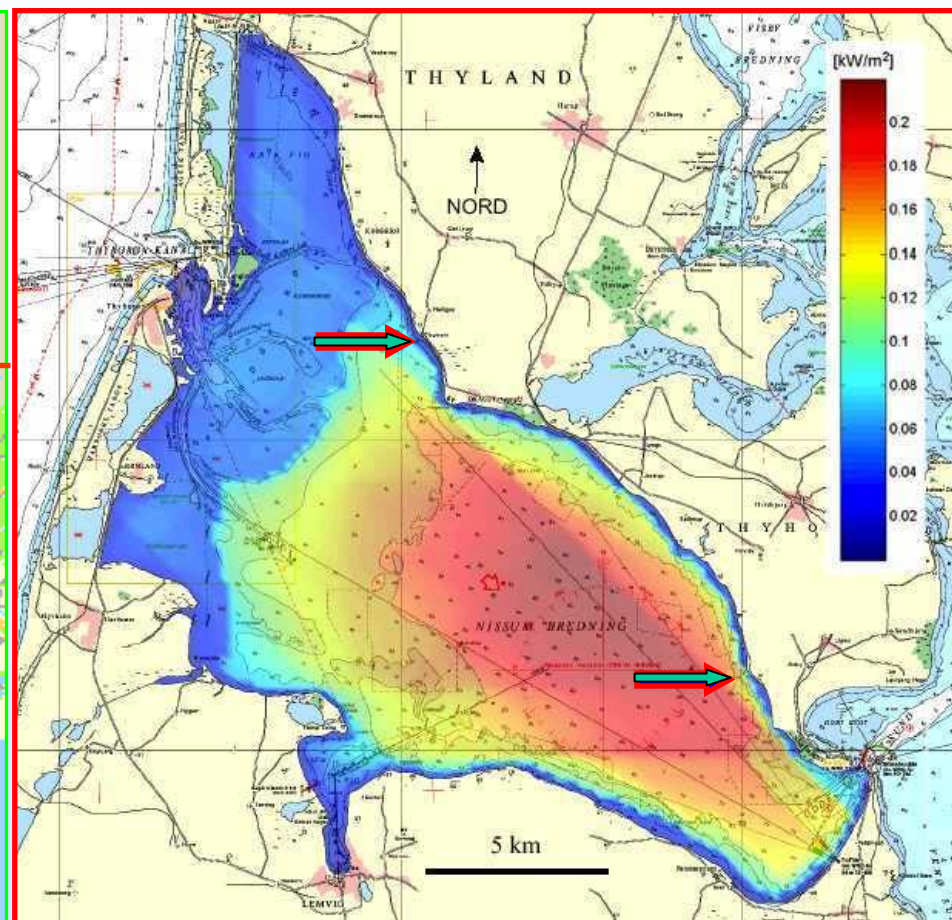
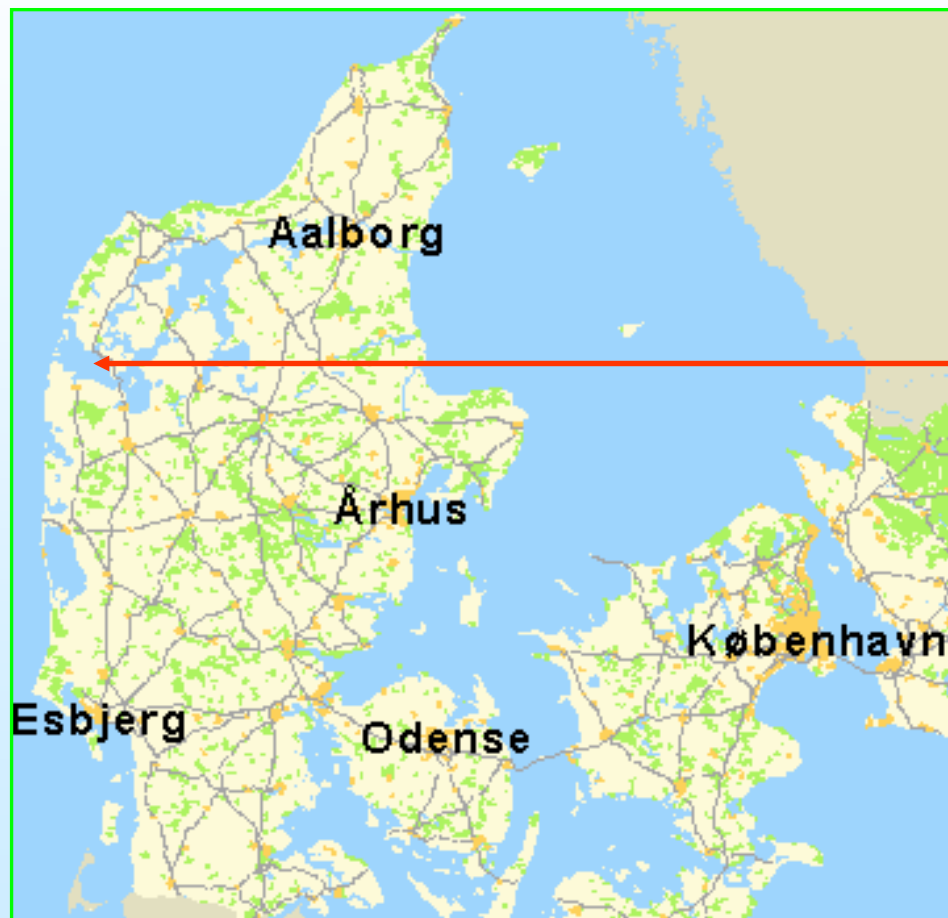




The Wave Dragon scale 1:4.5 prototype is deployed in a bird protection area (Ramsar)

Nissum Bredning, Denmark

The wave climate is – like the test rig - scale 1:4.5 of the North Sea.



Remote control

The screenshot displays a remote control interface for a turbine system, titled "BALSLEV AUTOMATION". The interface is divided into several sections:

- Top Bar:** Shows the IP address "62.121.165.194", a status bar with "264 17/11/03 04:07:33 PM" and "Turbine 9, dummy Timeout reaching end switch closed", and an "ACK Alarms" button.
- Navigation:** Buttons for "Overview", "Alarms", "Alarm archive", "Boyance", "Generators", "Configuration", "Graphs 1-4", and "Logout".
- System Parameters:**
 - Pressure: P [mbar] = 133, U1 [mbar] = 203
 - Level: Level [%] = 91,4
 - Other pressures: Pres. [mbar] = -1, R3 [mbar] = 7, R1 [mbar] = 9, R2 [mbar] = 6, U4 [mbar] = 6, U2 [mbar] = 187, U3 [mbar] = 166
 - Level percentages: Level [%] = 98,5, 95,9, 99,4
- Control Panels:**
 - Boyance:** Setpoint 15, Mode "Auto", Status "Running".
 - Generators:** Setpoint 0, Mode "Manual", Status "Running".
- Diagrams:**
 - A large schematic diagram of a turbine section with five numbered zones (1-5) and various valves (R1, R2, R3, U1, U2, U3, U4).
 - A detailed valve control diagram showing ACV11-ACV52 and Blower 2.
 - Trim and Heel angle diagrams for "Rear view" showing Trim SP (+0,20), Trim PV (+0,24), Floating level (51 [cm]), Heel SP (+0,20), and Heel PV (-0,12).
- Hardware:** "Blower 1" and "Hydraulic pump" are shown with motor symbols.
- Taskbar:** Shows Windows XP taskbar with "Start", "Windows Commander 4.5...", "WinCCExplorer - C:\Siem...", "WinCC-Runtime -", and system tray with "Remote Mouse", "Remote Keyboard", and time "00:38:15".
- Browser:** Microsoft Internet Explorer window showing "Medler" and "and Coastal Engineer" with address "Engineering - Sohngaardsholmsvej 57 - DK-90".

Marine growth

Marine growth on structure and mooring lines below waterline: 5-10 cm



Marine growth in turbine draft tubes reduces PTO. Non-toxic antifouling tested.



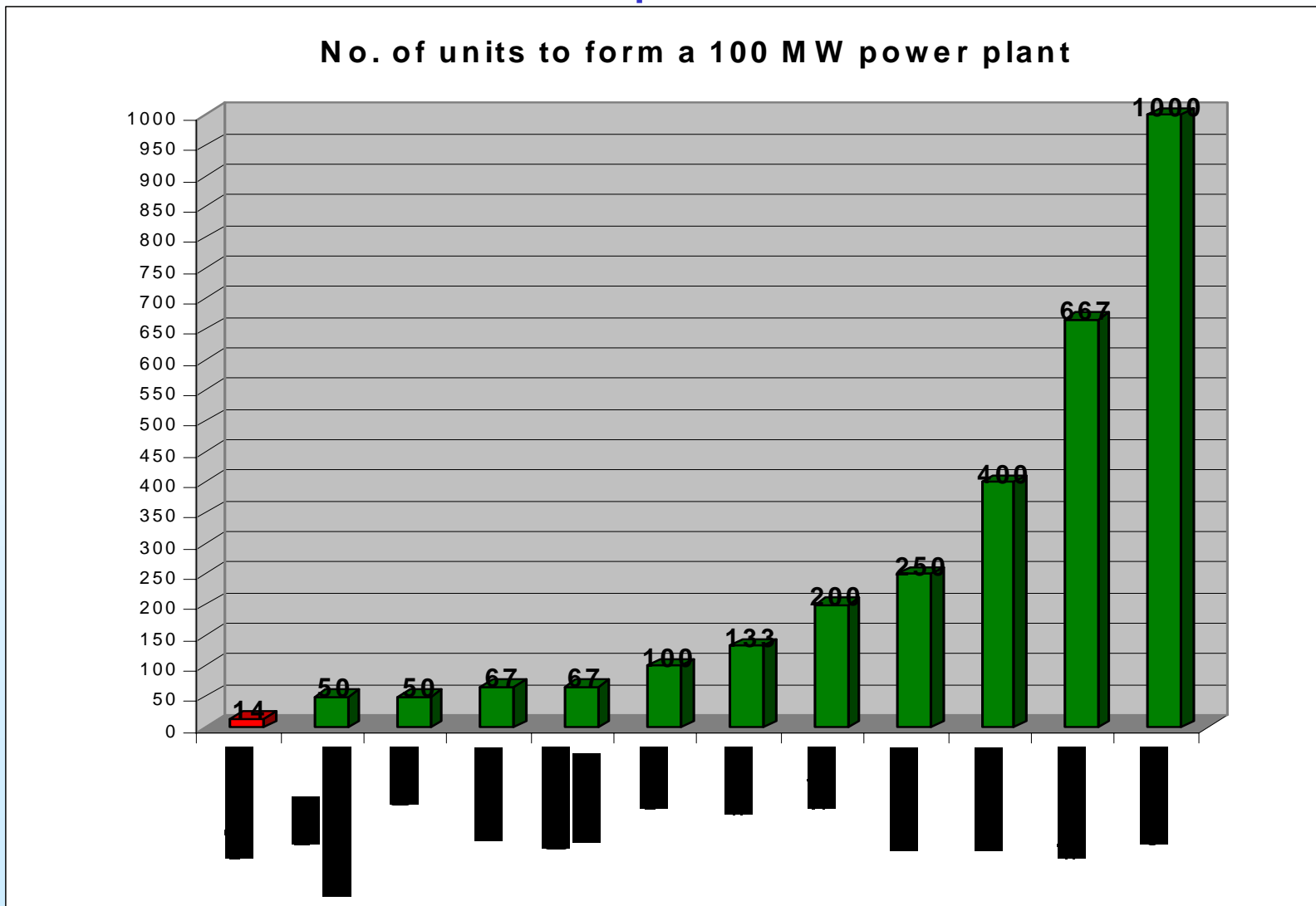
Wild life



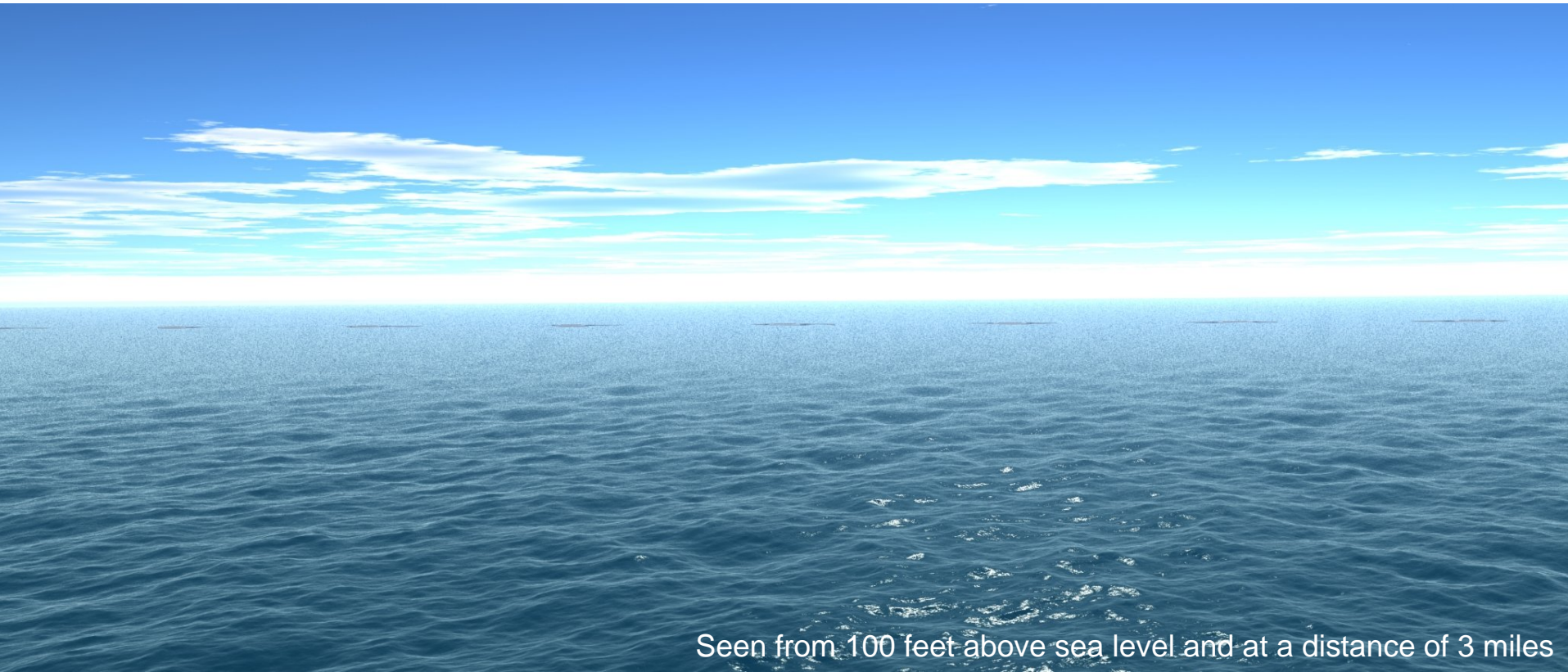
Cylinder gate turbines running



Power plant size



The Wave Dragon Vision



Seen from 100 feet above sea level and at a distance of 3 miles

- ☺ One and a half year operational experience
- ☺ Wave energy absorption performance verified
- ☺ Offshore wave energy is a reality