

Wave Dragon – A Floating Hydropower Plant

Werner Panhauser


Kössler GesmbH

St. Pölten - Austria

Hans Christian Sørensen, PhD

SPOK ApS and Wave Dragon ApS

Copenhagen - Denmark

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- The Wave Dragon Team
 - Wave Dragon technology
 - History of development
 - Real sea testing 1:4.5
 - The Welsh project 1:1
 - The future market

ABSTRACT:

Wave Dragon marks a significant breakthrough towards commercial exploitation of the abundant energy concentrated in ocean waves by re-positioning the proved hydropower technology into an offshore environment. Where previous wave energy converters have either failed to operate or only provided meagre potential for electricity generation, the seagoing trial of the Wave Dragon prototype has proved its offshore survivability for more than a year and verified the potential for commercial feasibility with large scale power generation below the costs of offshore wind power.

The global wave power potential is of the same size as world electrical energy consumption. The best wave climates are found between 30 – 60 degrees latitude with annual average power levels between 20 – 75 kW/m – orders of magnitude more powerful than solar and wind.

The Wave Dragon is an offshore wave energy converter of the overtopping type. The development work is largely built on the concept: use proved technologies when going offshore. The plant consists of two wave reflectors focusing the incoming waves towards a ramp, a reservoir for collecting the overtopping water and several hydro turbines for converting the pressure head into power. Wave Dragon is by far the largest wave energy converter known today. Each unit is rated to 4 – 10 MW or more depending on how energetic the wave climate is at the deployment site. Using the overtopping principle as opposed to power absorption by moving bodies means that the efficiency grows with the size of the converter. So only practical matter set limits for the size of this WEC.

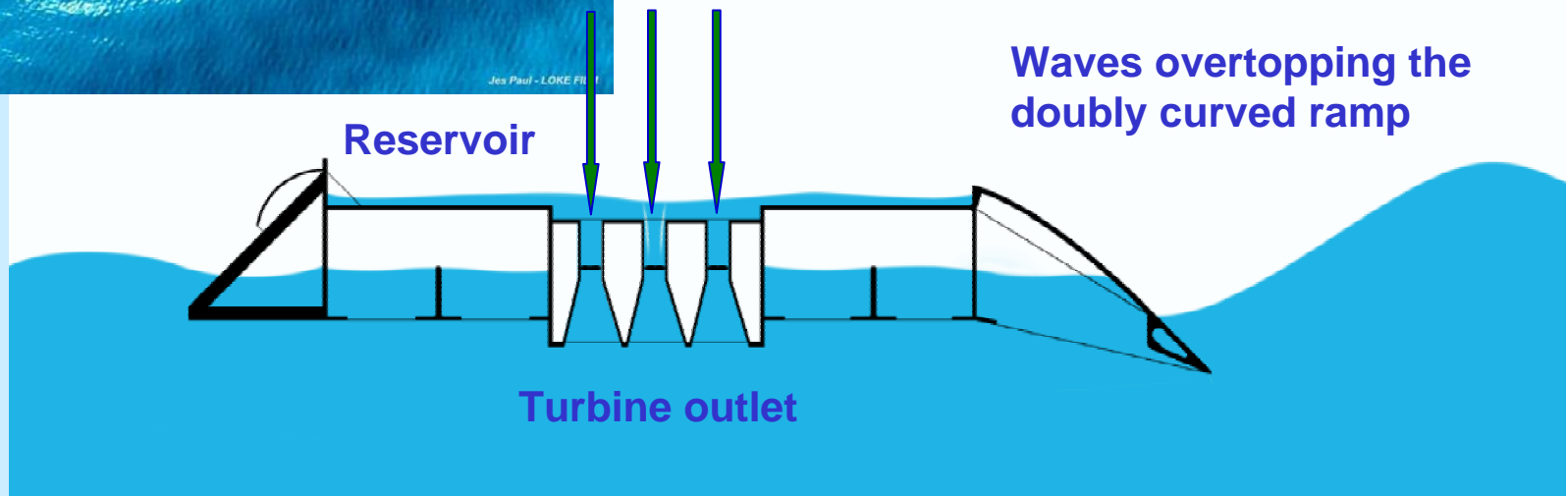
As part of the development activities towards a full size production plant in 2006 a grid connected prototype of the Wave Dragon in scale 1:4:5 has for the last two years been tested in a Danish fjord. The result of these more than 15.600 hours of continuously real sea tests will be used in the design of the 7 MW demonstrator to be deployed off the Welsh coast 2007.

Wave Dragon principle

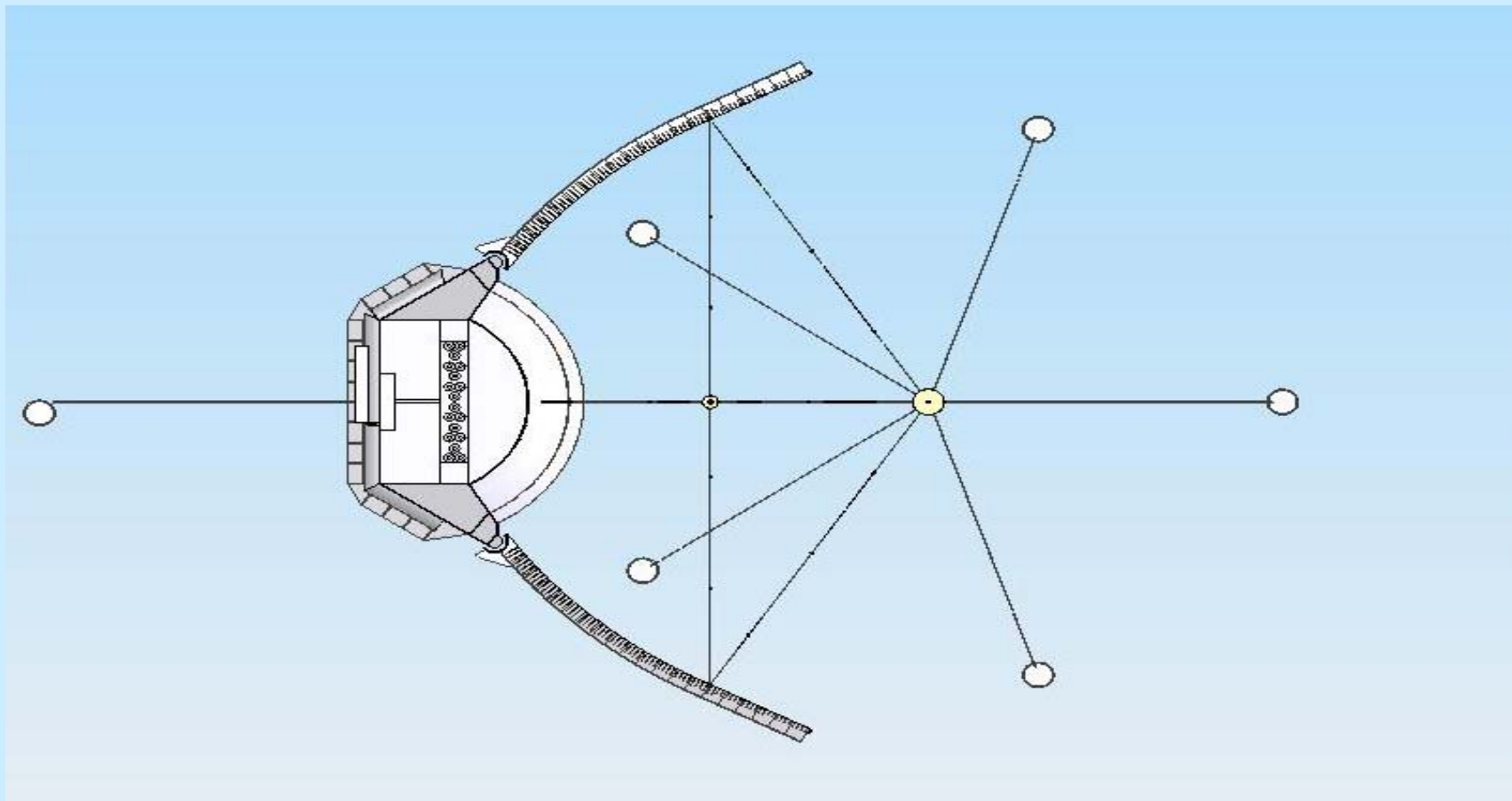
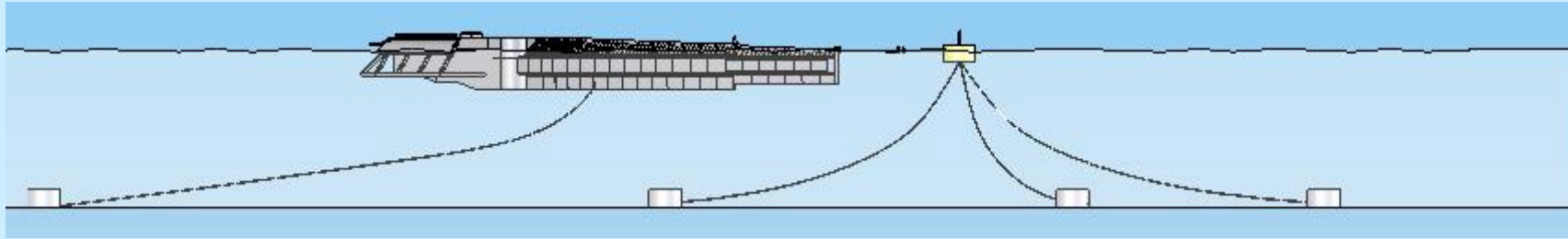
The *Wave Dragon* is a slack-moored wave energy converter that can be deployed alone or in parks wherever a sufficient wave climate and a water depth of more than 25 m is found.



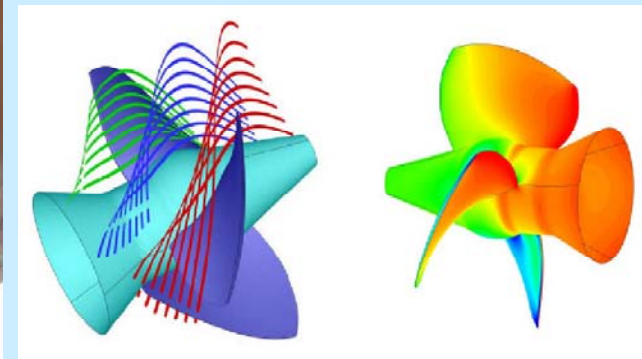
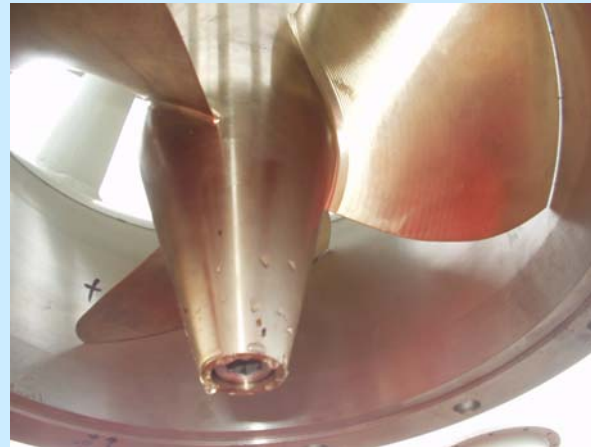
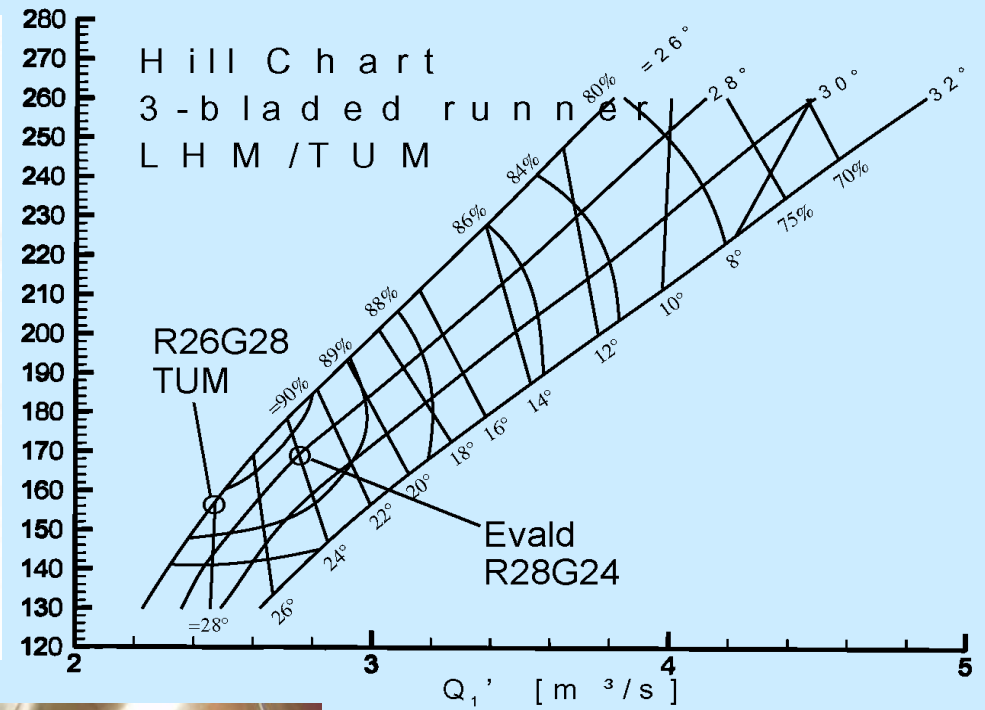
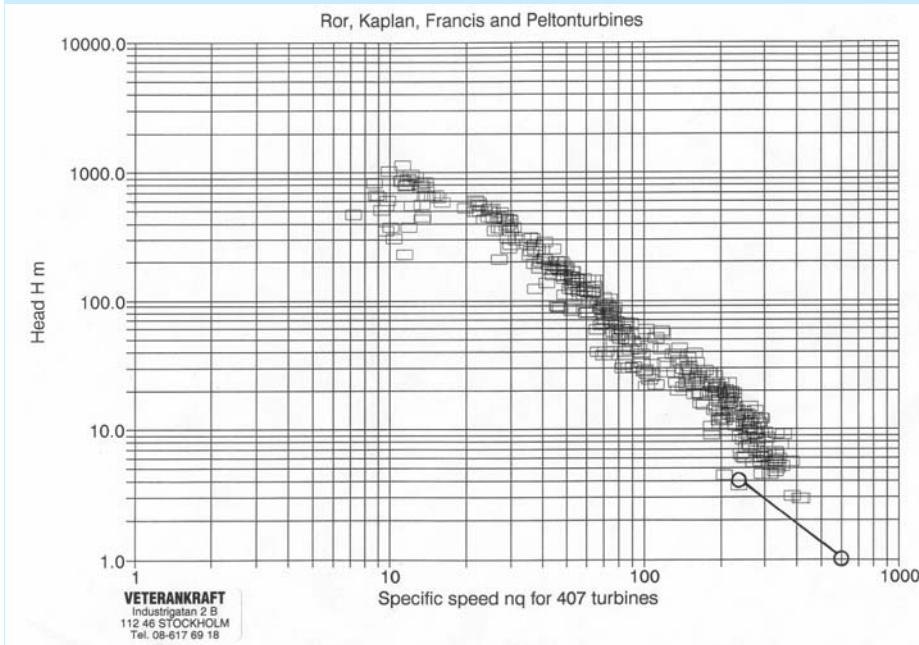
Climate	Power production
24 kW/m	12 GWh/unit
36 kW/m	20 GWh/unit
48 kW/m	35 GWh/unit



Mooring principle

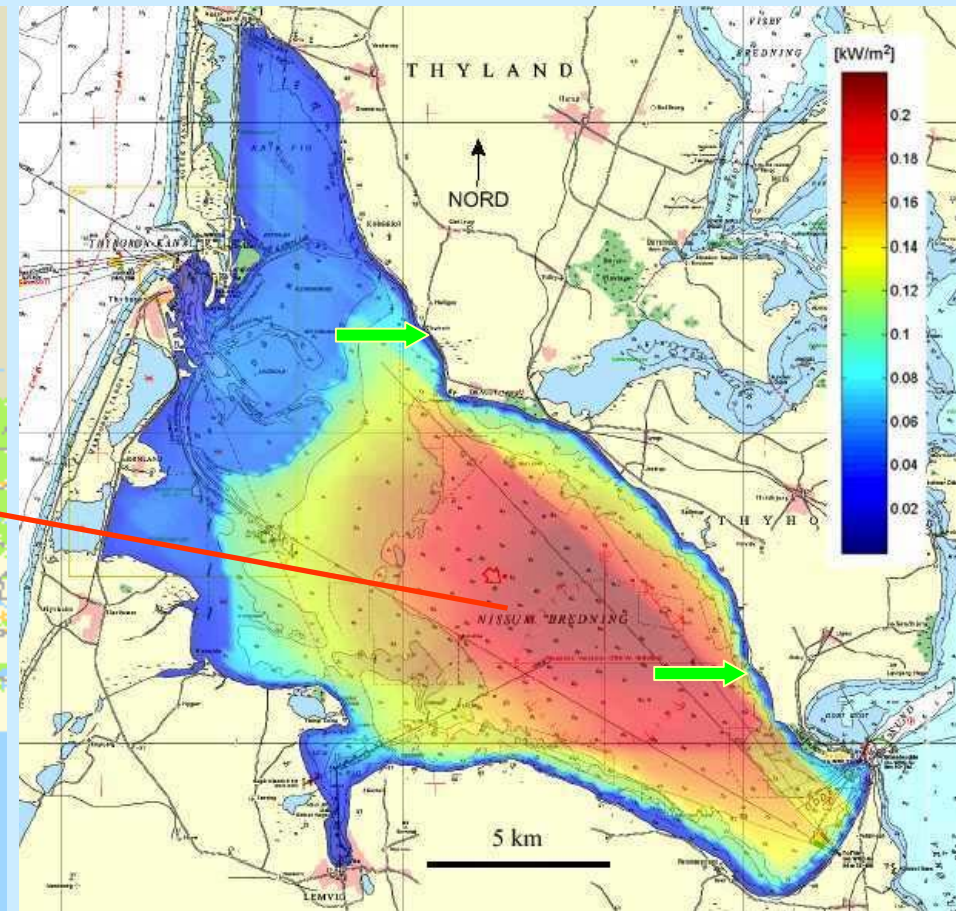
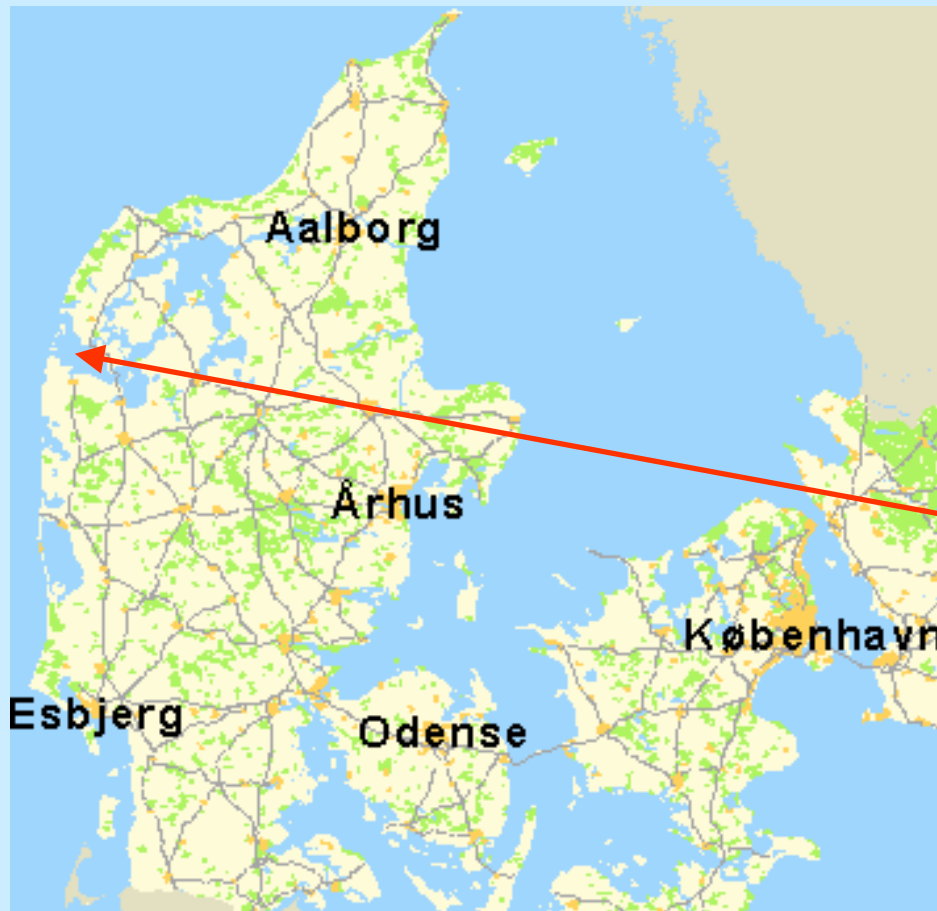


A turbine \varnothing 340mm has been developed

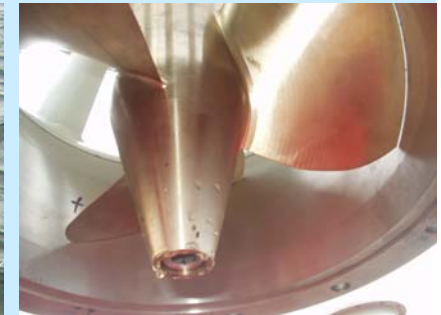


Nissum Bredning, Test site 1 and 2

The Wave Dragon is deployed in a fjord with a wave climate of scale 1:4½ of the North Sea in a bird protection area (Ramsar)



Wave Dragon - Influence of regulation strategy



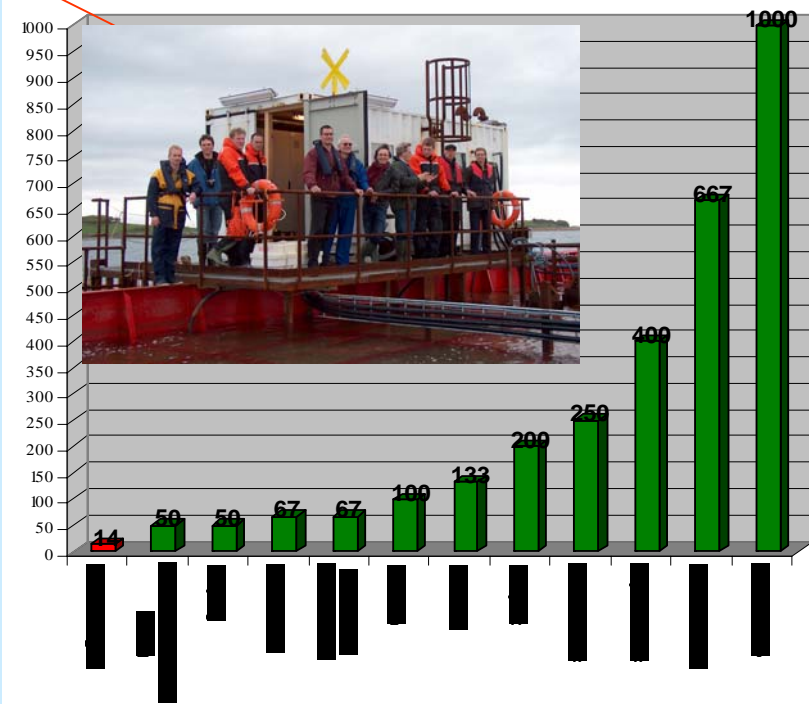
What makes *Wave Dragon* special?

- Through out documentation
- Experienced team
- Well known technology used in a new way
- Local production opportunities
- MW size

DEA / EU Joule Craft 1998-2000
DEA / PSO / EU Energie 2002-2006
Carbon Trust (UK) 2004-2005
EPRI (US) 2003-2005



No. of units to form a 100 MW power plant



Wave Dragon - The EC project: What next?

- Demonstrate regular power production from June 2003 ✓
- Demonstrate survivability – 15,600 operational hours track record with several storms ✓
- Optimise power production Spring 2006
- Optimise structural design Spring 2006



Wave Dragon - Perspectives



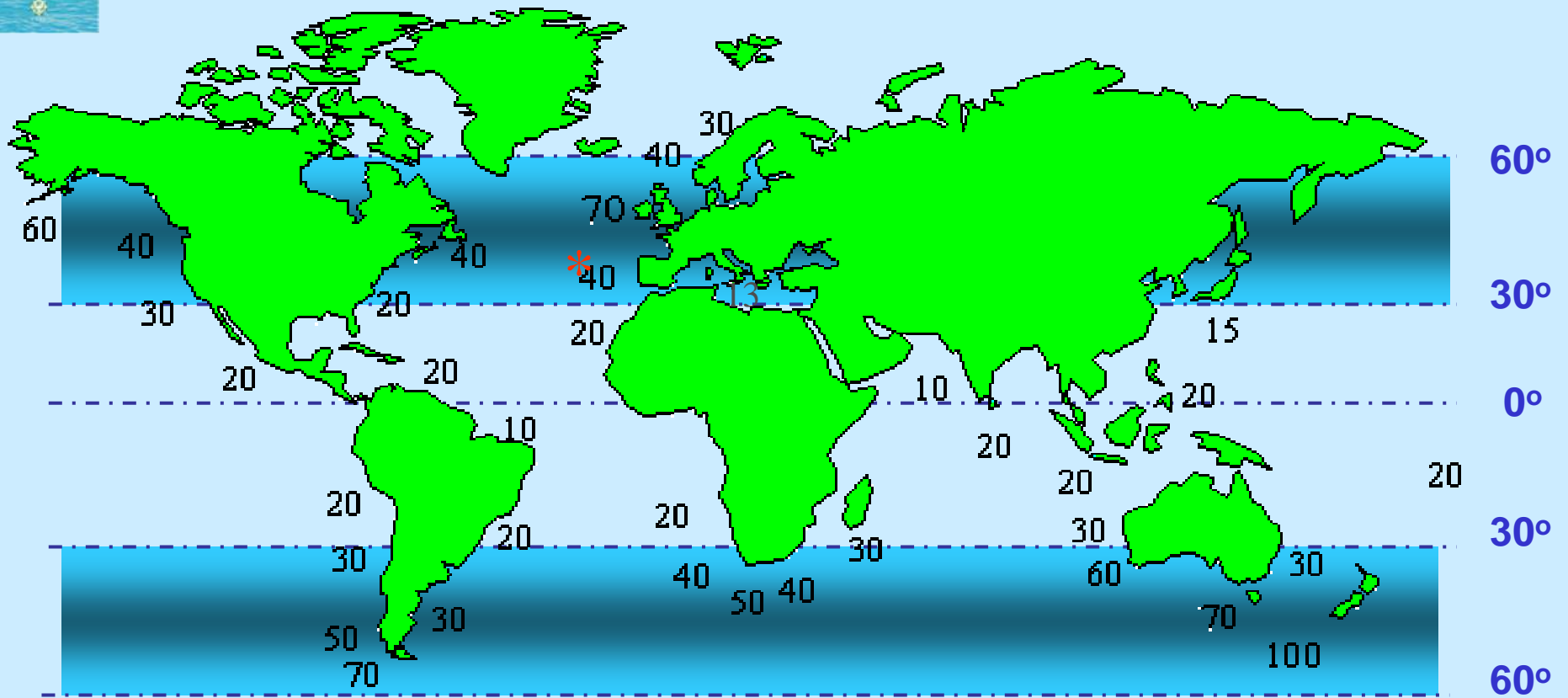
- We want to deploy a 4-7 MW unit by 2007 in Wales
- A power plant size solution for exploiting offshore wave energy by 2009
 - Made up of proven technologies
 - Unique design and construction – Patented
- Single unit power generating capacity of 20-30 GWh/year
- Power plant capacity 4 MW – 2,500 MW
- Long term installation cost < £ 1,000 per kW by 2011-2016
- Long term power generating cost of 2,4 – 2,9 pp/kWh by 2011-2016



Regions where wave energy is most feasible



50% of World energy demand can be covered by wave energy, WEC 2004



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

Wave Dragon - Objectives



- 2004: Reliable power production demonstrated and all wave situations tested
- 2006-7: Full size Atlantic unit 4 -7 MW unit to be demonstrated
- 2009-10: Power plant size to be demonstrated