



**SeaAngel™**  
The future of offshore wind



# The future of offshore wind

## Who is Mitsubishi Power Systems Europe, Ltd. (MPSE)?

As the daughter company of Mitsubishi Heavy Industries, Ltd. (MHI), Mitsubishi Power Systems Europe (MPSE) is part of one of the world's most innovative, successful and responsible businesses, MHI.

Founded in 2007 MPSE is headquartered in London with branch offices across Europe, tasked with driving forward MHI's power business in Europe, Middle East, and Africa.

In November 2010, MHI acquired Scotland based Artemis Intelligent Power, Ltd (AIP) after recognising the huge potential of Digital Displacement® technology, in particular in its application for the offshore wind market.

The local offshore wind development team are based in offices in London, Edinburgh, Glasgow and Hamburg. This team is supported by MHI colleagues in Yokohama, Nagasaki and Shimonoseki (our in-house hydraulic manufacturing division).

## What is SeaAngel™?

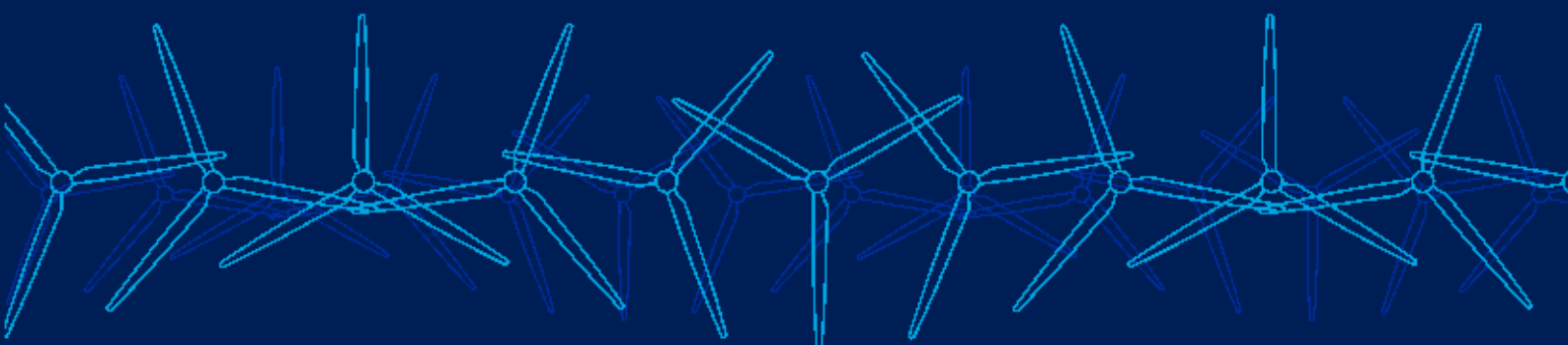


MPSE is proud to introduce SeaAngel™, its offshore specific wind turbine generator. The 7 MW-class SeaAngel™ offshore wind turbine will benefit from the Artemis pioneering DDT® hydraulic transmission system coupled with blades, whose rotor diameter is over 165m.



### Technical information

Rated output	7MW-class
Rotor diameter	Over 165m
Wind class	IEC-Class S
Drive system	Hydraulic transmission system
Generator	Brushless synchronous generator
Inverter	N/A



## Aren't hydraulic transmission systems inefficient?

Artemis Digital Displacement® technology replaces the port plates and swash plates in conventional hydraulic machines with computer controlled high speed solenoid valves. This enables very high operating efficiency in part-load conditions, and unprecedented controllability, especially in multi-service and synchronized applications.

### Key benefits of Digital Displacement® technology:



#### 1. High quality electrical output

Digital Displacement® technology enables the use of synchronous generators.

Synchronous generators are highly desirable as they rotate at a constant speed, meaning the SeaAngel™ offshore wind turbine shall be able to deliver a consistently high quality electrical output.



#### 2. Highly reliable and robust drive system

In a Digital Displacement® Transmission (DDT) system, there are many pumping modules working in parallel, sharing the burden, and each of them is protected against overload. In this way the DDT system has built in redundancy. This contrasts with the many serial failure modes that are common to many WTG drive train systems.



#### 3. Lower maintenance costs

The DDT system has an excellent operations and maintenance concept because of the large number of common parts, most of which are small enough to be carried by an individual technician. The weight of the heaviest component in the DDT system is just 25kg! Also, thanks to DDT system, SeaAngel™ doesn't need power convertors, which are the most common source of faults in wind turbines.



#### 4. Less complex and made from easily sourced materials

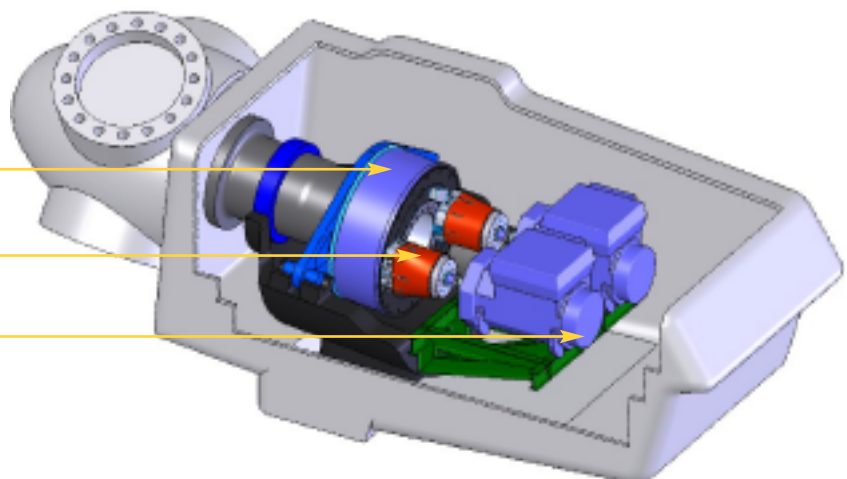
DDT is made of commonly available, recyclable, steel.

### Inside the nacelle of SeaAngel™

Digital Displacement® pump  
(low-speed ring cam pump)

Digital Displacement® motors  
(high speed)

Synchronous generators



## What is Mitsubishi's experience in wind power?



MHI has been involved with the research and development of wind energy conversion systems for the efficient exploitation of wind power since 1980, when

we built our first wind turbine, an experimental 40 kW machine.

Since then MHI has been developing technology in-house and has installed over 4,000 onshore wind turbines, growing its capability through the development of a range of onshore WTG's of up to 2.4 MW.

MHI has primary nacelle assembly facilities in Nagasaki Shipyard and Yokohama Machinery Works, in Japan, and has expanded its wind turbine operations through its US subsidiary Mitsubishi Power Systems America, Inc. (MPSA). A nacelle assembly plant in Arkansas is under construction, in addition MHI has a wind turbine blade manufacturing facility in Mexico.

MHI's knowledge of shipbuilding, large steel structures, aerospace and materials is being drawn upon in the development of the 7 MW class SeaAngel™ offshore specific wind turbine generator.

## Technology Validation

Rigorous validation of technology will help SeaAngel™ deliver customer value.

### Key testing milestones include:

**2011** DDT function test

**2012** 2.4MW DDT prototype WTG Onshore

**2013** Onshore & Offshore 7MW-class WTG prototypes





# SeaAngel™

## The future of offshore wind

With our cutting edge Digital Displacement® technology, we strongly believe that SeaAngel™ is the solution that the offshore wind market needs in order to help secure a sustainable future. Although Mitsubishi was born in Japan, it sees its duty in developing technologies that will benefit the world as a whole. SeaAngel™ is the next step on this journey.

**Our target is to become a leader in the European offshore wind market, MPSE intends to:**

- 1. Establish a European centric supply chain**
- 2. Establish a European offshore wind turbine assembly facility**
- 3. Establish dedicated local offshore wind service and maintenance facilities**





**Mitsubishi Power Systems Europe Ltd**

20 North Audley Street

London W1K 6WL

**Telephone** +44-(0)207 647 0754

**Email** enquiry@mhips.com

[www.mhips.com](http://www.mhips.com)