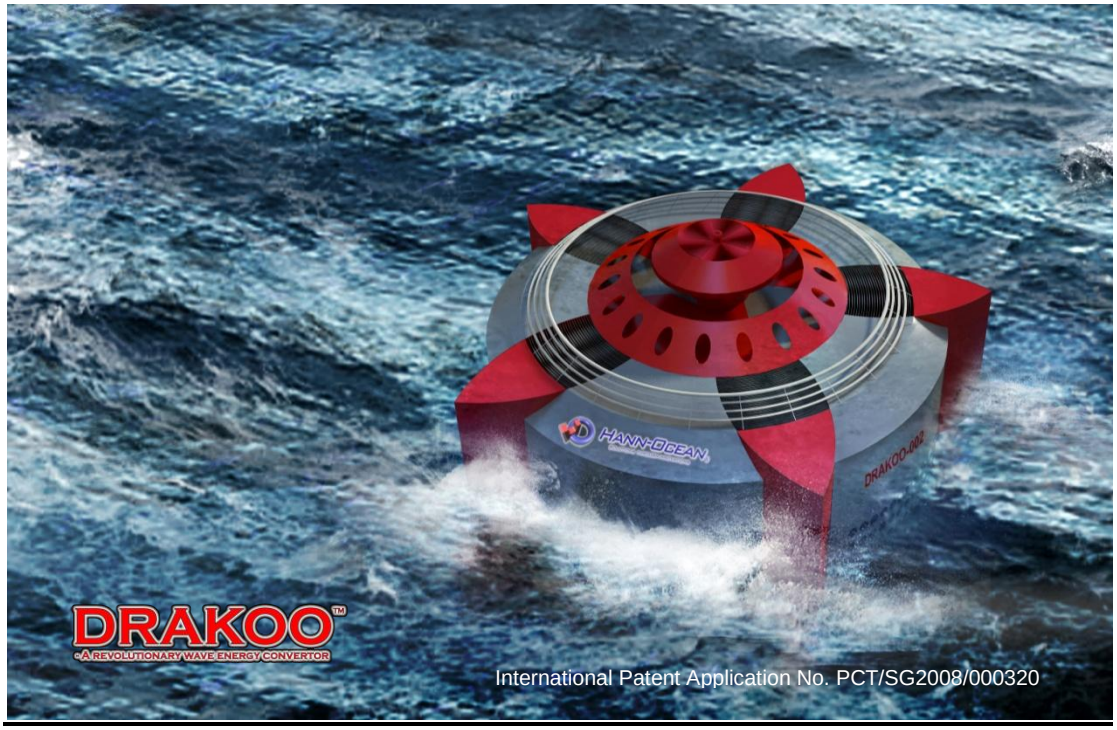

A Highly Efficient & Cost-Effective Ocean Wave Energy Convertor - DRAKOO being developed by Hann-Ocean Technology

January 2011

1. Innovation

Hann-Ocean has developed a novel design concept for wave energy conversion, namely **"DRAKOO"** Wave Energy Converter. This is a system for absorbing, concentrating and converting wave energy into electricity while reactively cancelling or reducing reflective wave energy of sea waves. The DRAKOO can absorb both the sea wave's potential and kinetic energy and drive hydro-turbines to generate electrical power.

The DRAKOO device absorbs wave energy providing great effect of damping to incident wave. The concept has been proven in wave tank model tests. The efficient design of the Drakoo enables it to achieve high energy absorption efficiency for incident waves with wide range of wave periods. When the external sea wave is energetic, a hydro-turbine can be fitted into DRAKOO to convert incident wave energy to electricity.

The main body of DRAKOO has a simple structure made up of steel or reinforced concrete or composite material. It has limited number of moving parts which are modular by design for easy installation, replacement and maintenance. By design principle, the cost of fabrication will be low. Furthermore, the hydro-turbine is designed to be a single module integrated with gearbox using "Plug-n-Run" concept for easy access and maintenance whenever necessary. DRAKOO is therefore a cost-effective and reliable solution for wave energy absorption or conversion.

DRAKOO design concept was developed by Mr. Henry Han Lei and it has been filed for international PCT patent application (ref. no. PCT/SG2008/000320).

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2. Value Proposition

Traditionally, seeking methods to harvest wave energy is not new, with the first concept patented in 1799. However, few of the many technologies patented since then have resulted in economically viable ways of converting wave energy. While wind energy development has been advancing rapidly in the past 20 years, ocean energy conversion technology and commercialization, especially in the field of wave energy, is lagging behind mainly because of little proven consistency of suitable energy sites and low efficiency as well as high installation costs. Today, dynamic increase in oil price forces people to reconsider various possible sources of renewable energy including wind, wave, tidal, solar and thermal. Among these, sea wave energy has the highest energy density among the renewable energy sources. Wave energy provides "15-20 times more available energy per square meter than either wind or solar".

3. Challenges

The challenges that many existing wave energy converters face are:

- Workable in specific wave condition only. A wave energy converter may work efficiently in its design conditions in terms of certain range of wave height and wave period/length. But, it may become idling beyond its operational range.

- Poor survivability in extreme weather /sea state. Designing a structure that can withstand storms, is very costly for most of the existing design concepts. This makes conventional wave energy converters to be non-economical and impractical.

- Large variation of power output. Due to a great variation in wave height and period from time to time, there is lack of consistency in electrical power output of most wave energy converters.

- Directional conversion efficiency. Energy conversion efficiency for many offshore wave energy converters depends on incident wave direction, while shoreline base wave energy converters receive incident wave constantly perpendicular to the shoreline. However, wave energy density near shoreline is usually lower than offshore. Therefore, selection of wave farm site for maximum average power output is also a challenge.

- Limited conversion efficiency of device itself. Most of the existing wave energy converters have conversion efficiency factor of 10~15% and the industry leader Pelamis have 26% conversion efficiency under ideal design conditions.

- High cost for commercial applications. High initial fabrication cost and site installation as well as power transmission cost.

- Durability and Maintenance. Corrosive environment at sea is another challenge for most of wave energy devices to keep operational for long period. Movement of device in high sea also imposes extreme difficulty for regular maintenance for complex device.

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4. Our Solution

With this background in mind, Hann-Ocean has developed a novel design concept for wave energy conversion, namely DRAKOO – “Dragon King of Ocean”. This device has met the above-mentioned challenges with solutions as follows:

Type B

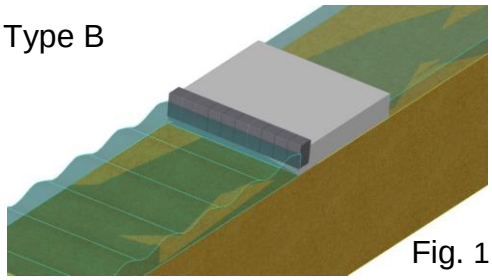

Fig. 1

Type R

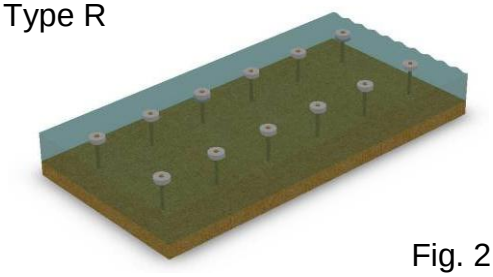

Fig. 2

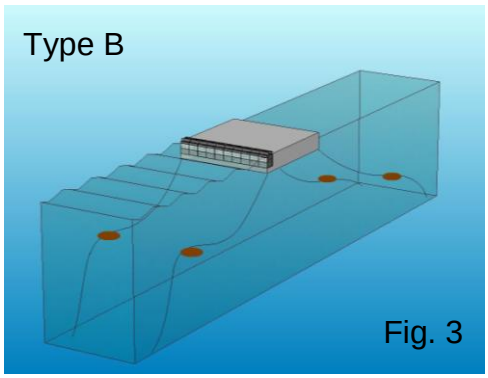

Fig. 3

Type R

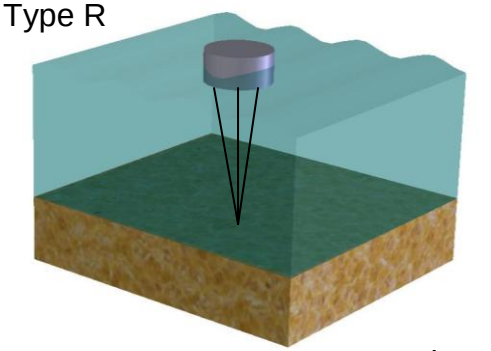

Fig. 4

- **High efficiency** (up to 66%, based on the latest wave flume tests conducted in NTU) for converting wave to water jet driving an impeller-type turbine connected to a DC alternator.
- Applicable for any wave condition without technical limit.
- Simple structure with limited number of moving parts for easy installation and maintenance.
- Single module hydro-turbine integrated with gearbox using “Plug-n-Run” concept for easy access and maintenance
- Robust and stress-release design features making DRAKOO capable of surviving in high seas.
- Low cost of fabrication using conventional material like steel and/or RC concrete.
- Four (4) typical design varieties namely Type B-I&II and Type R-I&II developed for shallow water, medium-depth costal sea and deep sea, respectively to produce reliable power in directional or non-directional waves
- Multiple combinations of fixed-breakwater-type or floating-platform-type wave energy absorbers/converters or floating point absorber to form wave farm by large array
- Minimum impact to underwater current and seabed
- Safe for fishes and other marine lives
- Low noise
- Minimum use of sea surface area

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With on the above solutions, DRAKOO will therefore be a cost-effective and reliable solution for wave energy absorption and/or conversion.

5. Potential Applications

DRAKOO has high design scalability because of its several potential applications including, but not limited to:

- Type B fixed costal breakwaters (Fig.1)
- Type B or R independent wave farms (Fig. 2)
- Type B floating wave breakers (Fig. 3)
- Type R integrated into existing coastal wave farms (Fig.4)
- Type R integrated into existing offshore wind farms
- Type B or R detachable to existing vessels or oil rigs
- Type B inner tank sloshing damping for ships/vessels
- Type B reactive ship stabilizers

Based on fundamental comparisons, we anticipate that DROKOO will be able to produce electricity at 3.5 pence per kW/hr in Northern Europe where the usual wave height is 5m.

Currently we are looking for private investments and/or government funding as well as industrial partners to speed up the development and commercialization.

A comprehensive plan for the DRAKOO product development and its commercialization is available for review upon signing a NDA with Hann-Ocean.

For further information, please contact us via email at enquiry@hann-ocean.com.

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