

DRAKOO

Energize the Future with Ocean Waves

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Presented by

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AGENDA

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2. Drakoo Working Principle
3. Developing Milestones
4. Key Features and Advantages
5. Technical Specifications
6. Performance and Benefits
7. Applications
8. Case Study
9. Live Demo. via the Internet



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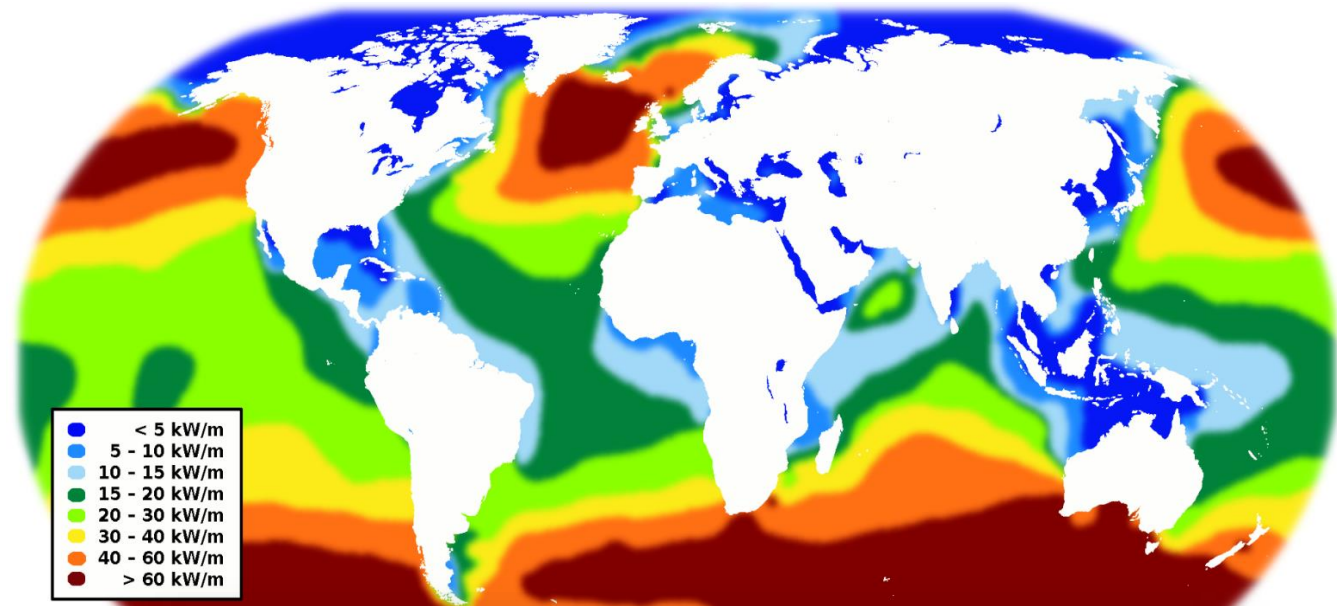
Energize the Future
with Ocean Waves

Why Wave Energy?

1. A vast, untapped resource of renewable energy
2. Wave energy much denser than wind and solar energy in kW/sq.m
3. Easier to forecast
4. Can be harnessed 24/7

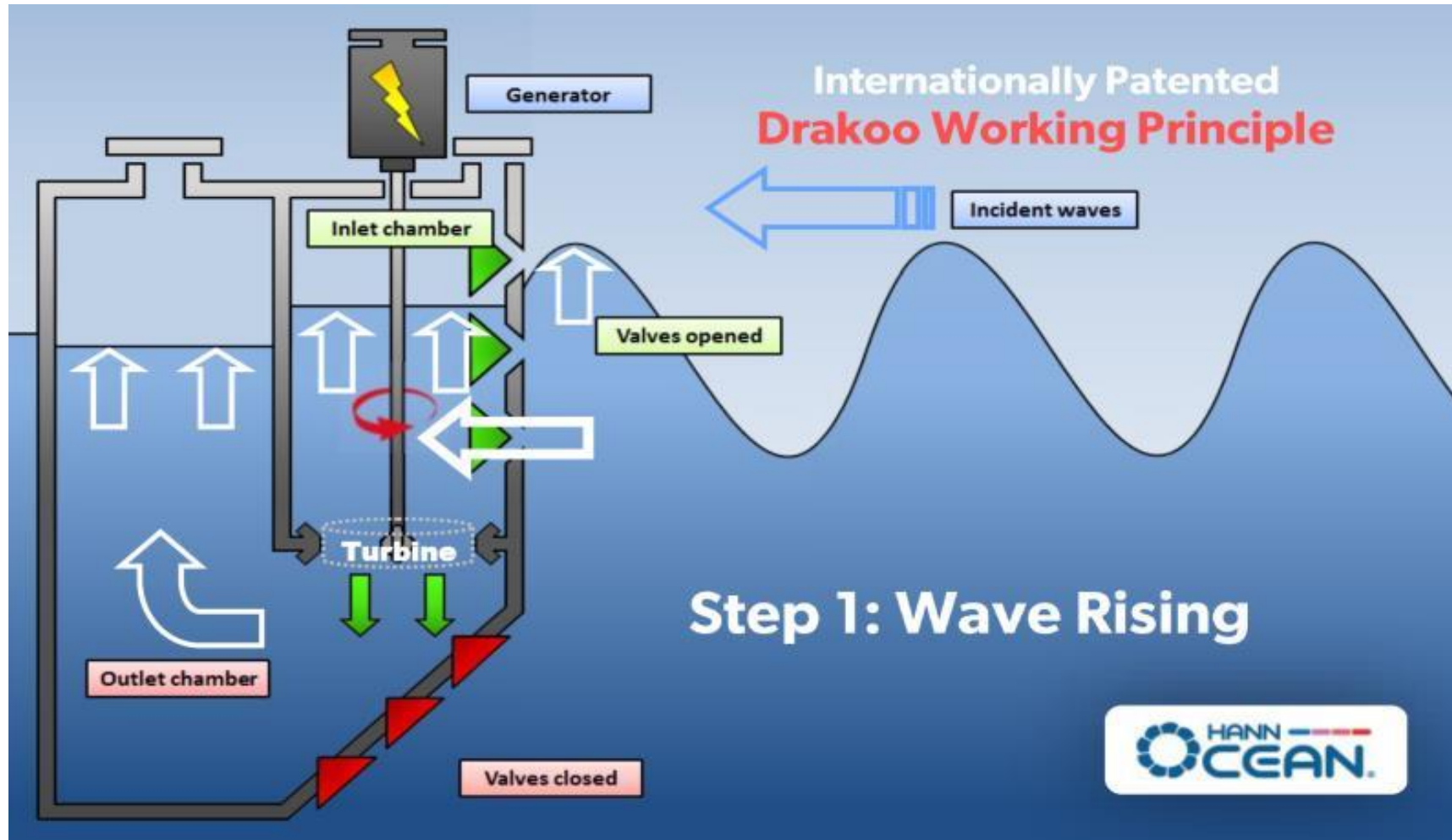
The world's total theoretical potential of wave energy is estimated to be 29,500TWh per year. Source: Mork et al. (2010)

Global Offshore Annual Wave Power Density Distribution

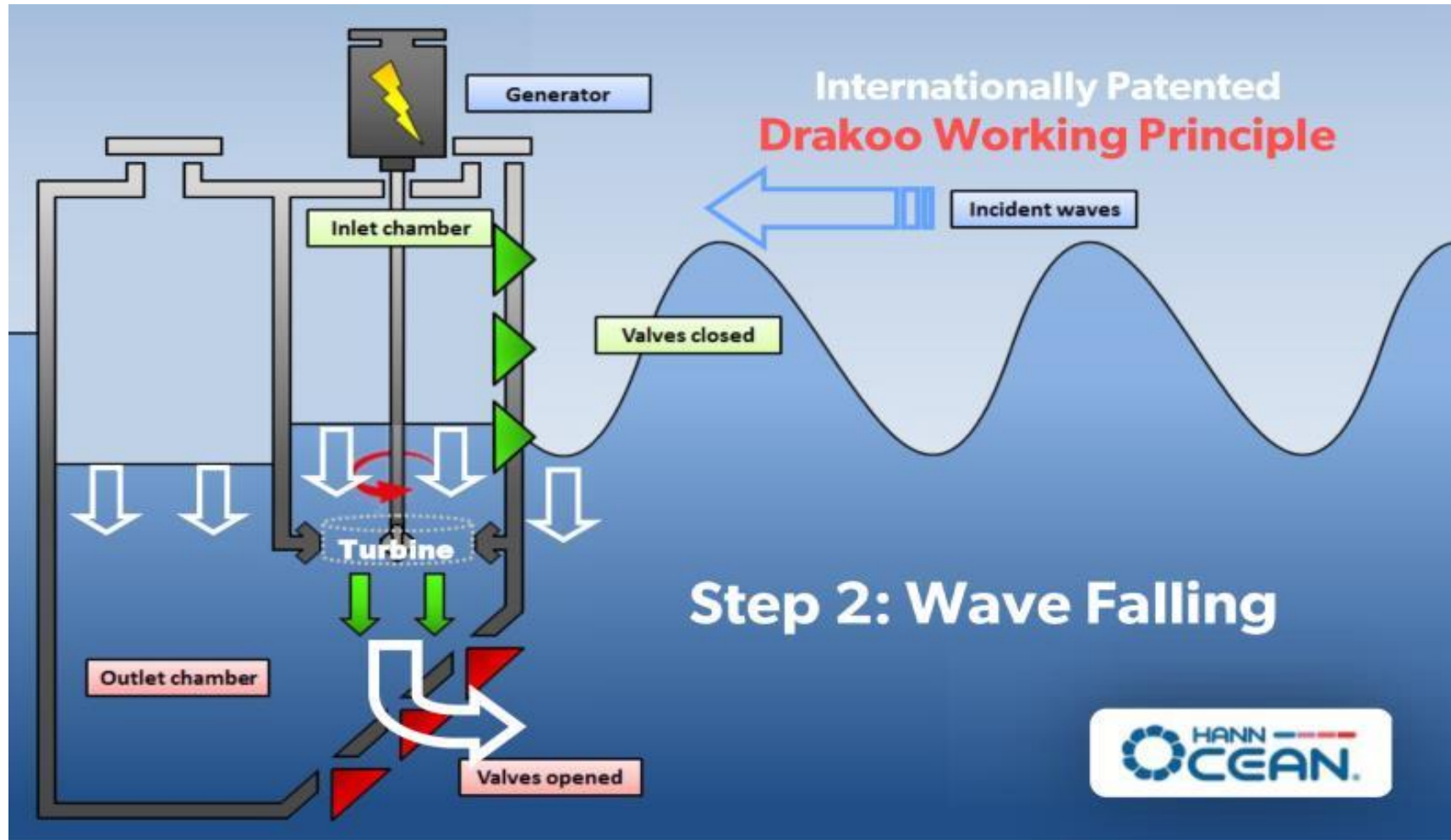


Wave Flux			Drakoo Flux		Yearly Energy Output
kW/m					kWh/m
0	-	5	2.5	0.5	4,555
5	-	10	7.5	1.6	13,666
10	-	15	12.5	2.6	22,776
15	-	20	17.5	3.6	31,886
20	-	30	25.0	5.2	45,552
30	-	40	35.0	7.3	63,773
40	-	60	50.0	10.4	91,104
60	-	100	80.0	16.6	145,766

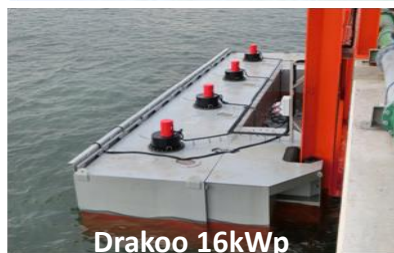
Drakoo Working Principle



Drakoo Working Principle

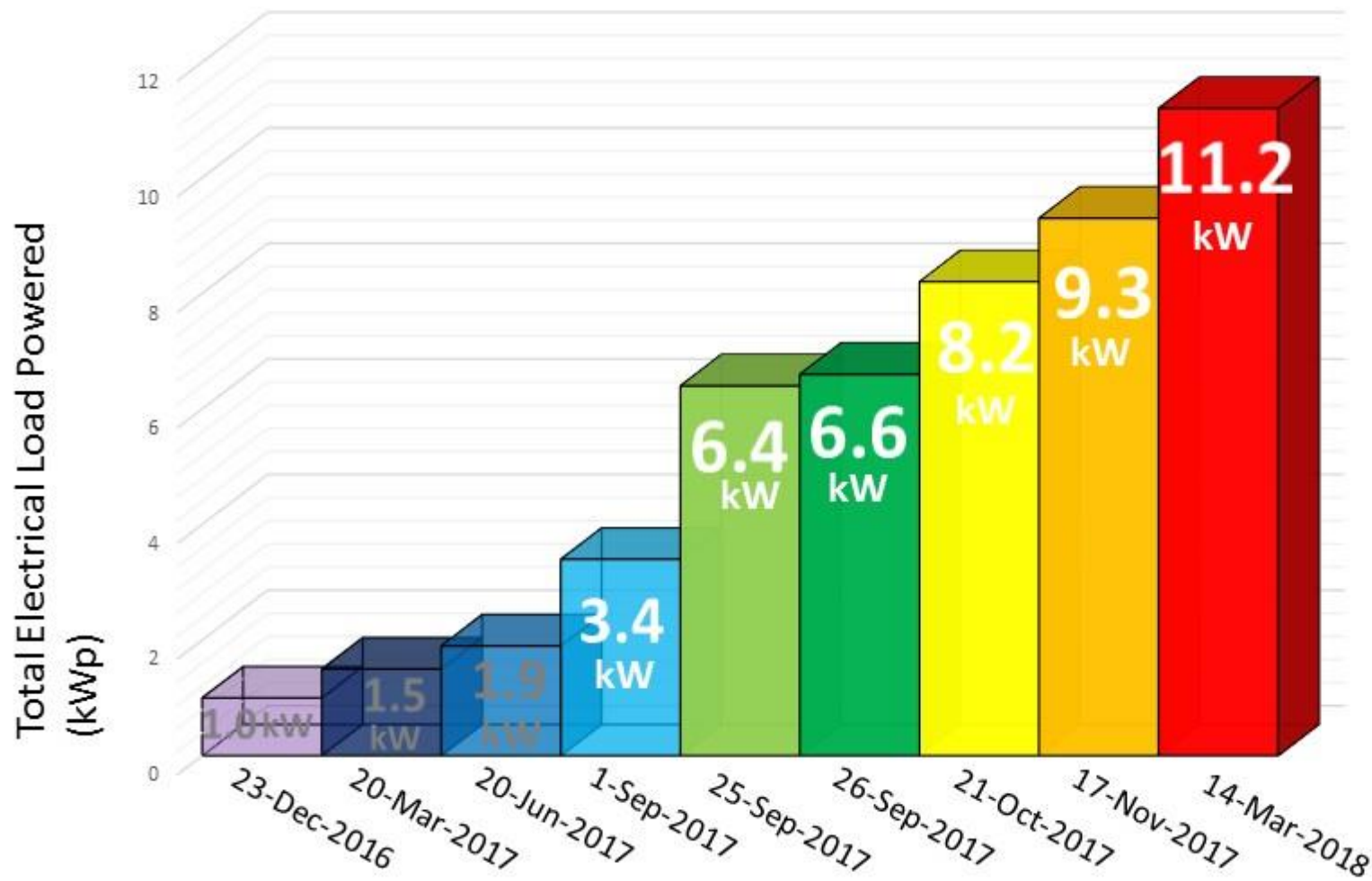


Development Milestones



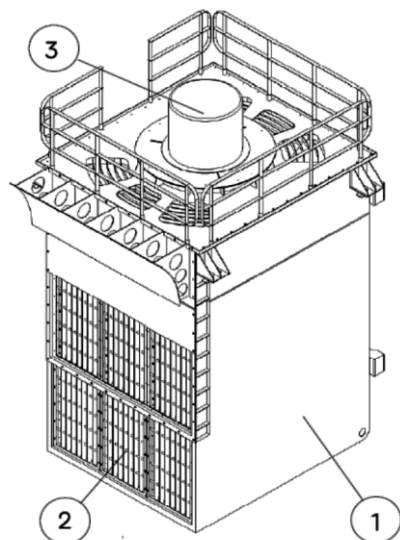
Aug. 2008	International patent of the Drakoo WEC concept filed
Sep. 2010	1:5 scale Drakoo model tested in Nanyang Technological University (NTU), achieving a peak Capture Wave Ratio (CWR) of up to 66%
Jul. 2011	1kWp Drakoo prototype tested at National Renewable Energy Centre UK (Narec), achieving a peak CWR beyond 80%
Jun. 2012	1 st commercial order from Sembcorp Marine secured
Oct. 2012	4 units of Drakoo 4kWp delivered to Sembcorp Marine
Nov. 2012	Drakoo 4kWp sea trial conducted
Aug. 2013	Drakoo 16kWp array deployed in Tuas View Sea
Feb. 2015	Hann-Ocean Energy's subsidiary in China registered
Nov. 2015	"Hann-Ocean 01" ocean wave tank construction completed
Jul. 2016	"Hann-Ocean 01" wavemaker (120kWp) installed and tested
Dec. 2016	Drakoo 10 kWp full-system assembled and started generating electricity
Nov. 2017	Drakoo 10kWp reached its peak electric capacity
Oct. 2017	Sales enquiries from the Persian Gulf for wellhead platforms and South Africa
Jun. 2018	Further upgrade the entire electric system to 15kWp

Drakoo Power Record



Through our continuous effort in the Drakoo design optimization and the product improvement, the Drakoo power output performance in terms of peak power, rms power and stability is progressing rapidly, starting from 1kW to 11.2kW in 15 months only.

Key Features and Advantages



Design Configuration:

- 1) Twin-chamber Hull
- 2) Checkerboard Valves
- 3) Power Take-off System

The Internationally patented modular design enables constructions of large-scale wave power arrays by connecting multiple units using bolting, welding or Hann-Ocean's Rigid Pontoon Connectors.

Simplicity Plug & Run power take-off; In modular configuration

Efficiency High Efficiency, up to 50% overall energy conversion

Reliability Use of commercially available parts for key components

Durability Self-pressure relieving feature in stormy seas

Eco-friendliness Harmless to marine life, minimal impact on sea environment

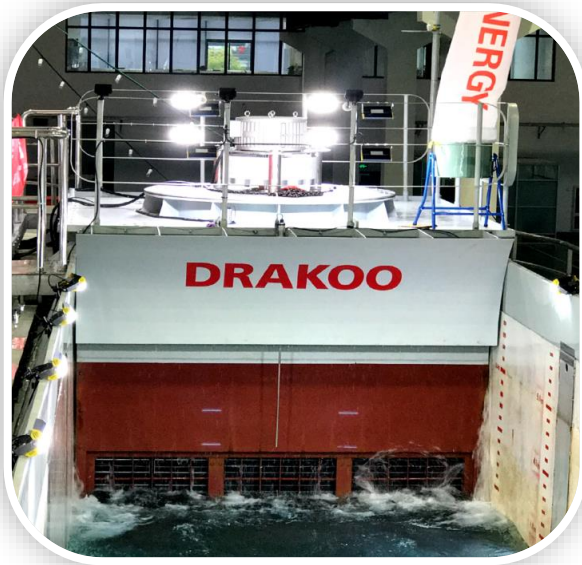
Cost-effectiveness Low material costs and economically justifiable pricing

Versatility Applicable at shoreline or far offshore, in fixed or floating mode

Scalability Installation capacity variable from kW unit to MW array

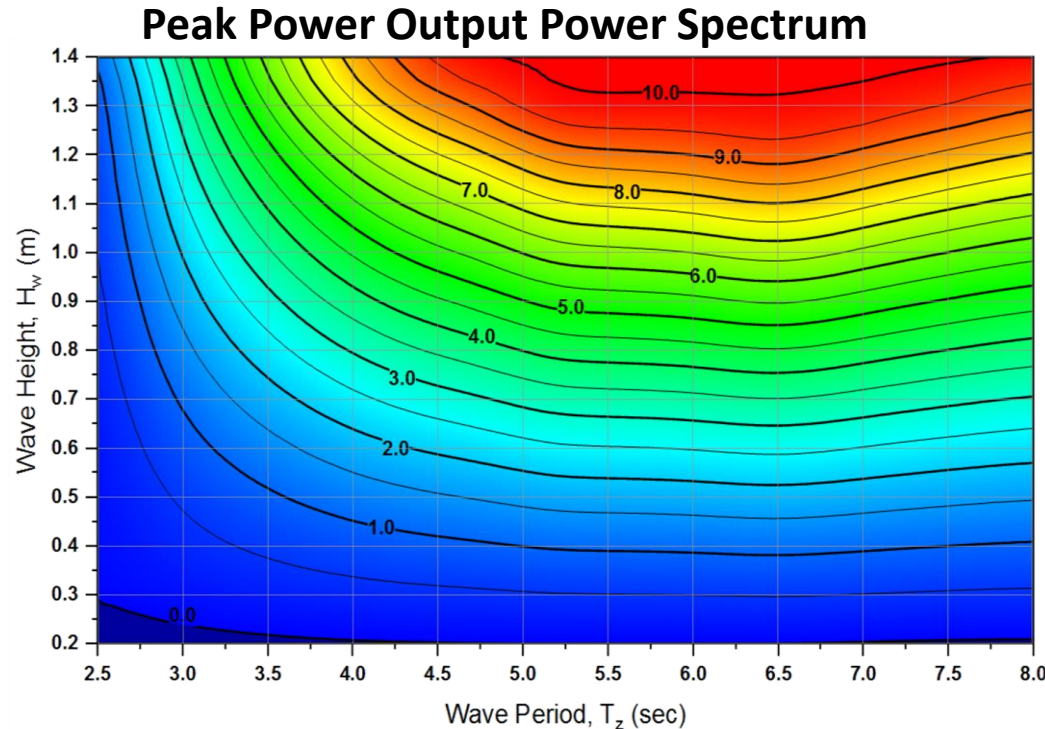
Technical Specifications

DRAKOO



Model No.:	B0010	Version:	012018
Length (L)	3.0 m		
Width (B)	3.5 m		
Height (H)	5.1 m		
Weight (W)	12 ton		
Peak Output Wave Height (H_w)	1.3 m		
Optimal Wave Period (T_z)	5 sec		
Electricity Generator	Permanent Magnetic AC Generator		
Peak Power Output	10 kWp		
Peak Efficiency	Up to 50%		
Wave Absorption	Up to 80%		
Position Keeping	Attached or integrated into floating platforms or fixed structures		

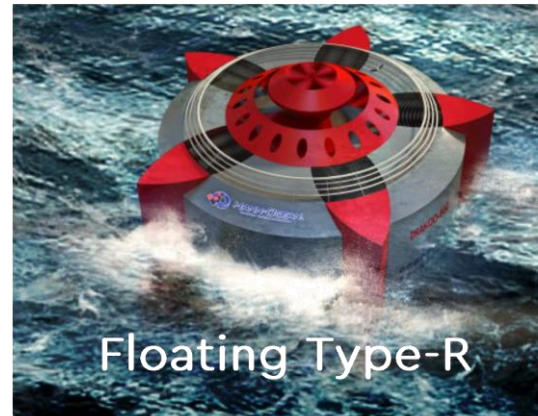
Performance and Benefits



- ❖ Internationally patented
- ❖ Proven in labs and seas
- ❖ Cost-effective solution to replace diesel generators
- ❖ Brand-new technology for wave energy to meet growing global demand for clean energy
- ❖ Especially in island communities and remote offshore operations.

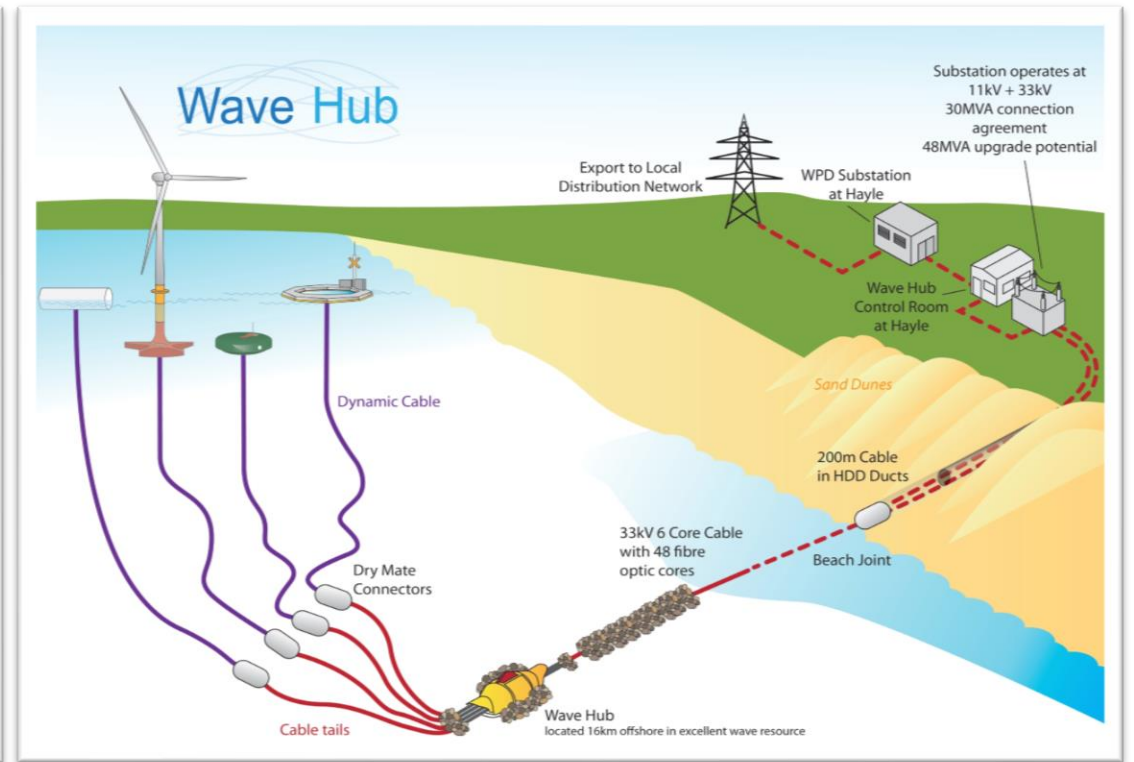
Applications

- ❖ Fixed modular Drakoo WEC array, e.g. [fixed breakwaters](#)
- ❖ Floating modular Drakoo WEC Array, e.g. [Drakoo Type-X](#)
- ❖ Floating Stand-alone Drakoo WEC, e.g. [Drakoo Type-R](#)
- ❖ Integrated with floating or fixed structures along shorelines, e.g. [floating sports hubs](#)
- ❖ Integrated with floating or fixed offshore structures, e.g. [oil and gas production platforms](#),
[fish farms and offshore wind turbines](#)



Case Study

Wave Hub at Cornwall, United Kingdom One of the ideal wave test sites on the globe



UK government has invested 42m£ in Wave Hub

Case Study

Wave Hub – Cornwall, United Kingdom

Resource Assessment

Wave Occurrence		Zero-Crossing Wave Period (Sec)																		Total	Availability			
		3.25	3.75	4.25	4.75	5.25	5.75	6.25	6.75	7.25	7.75	8.25	8.75	9.25	9.75	10.25	10.75	11.25	11.75		12.25	upto 3.0m	upto 3.5m	upto 4.0m
Significant Wave Height (m)	0.25	0.1	0.4	0.2	0.1	0.1	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	1.1	81.6%	87.9%	92.1%
	0.75	0	0	0.6	1.4	1.8	1.9	1.8	1.9	1.9	1.5	0.8	0.4	0	0	0	0	0	0	0	14			
	1.25	0	0	0	0.1	0.9	2.5	4.0	4.0	3.4	2.8	2.3	1.8	1.1	0.5	0.3	0.1	0	0	0	23.8			
	1.75	0	0	0	0	0	0.2	1.4	3.0	3.4	3.1	2.6	2.1	1.6	1.1	0.6	0.4	0.2	0.1	0	19.8			
	2.25	0	0	0	0	0	0	0	0.6	2.1	2.5	2.2	1.9	1.5	1.2	0.9	0.5	0.2	0.1	0	13.7			
	2.75	0	0	0	0	0	0	0	0	0.3	1.4	1.8	1.6	1.3	1	0.7	0.6	0.3	0.1	0.1	9.2			
	3.25	0	0	0	0	0	0	0	0	0	0.2	1	1.4	1.2	0.9	0.7	0.4	0.3	0.1	0.1	6.3	18%	11%	7%
	3.75	0	0	0	0	0	0	0	0	0	0	0.2	0.8	1	0.8	0.5	0.4	0.3	0.1	0.1	4.2			
	4.25	0	0	0	0	0	0	0	0	0	0	0	0.2	0.7	0.8	0.5	0.4	0.2	0.1	0.1	3			
	4.75	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.5	0.5	0.3	0.2	0.1	0.1	1.9			
	5.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.3	0.3	0.1	0.1	0	1			
	5.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.3	0.2	0.1	0	0.7			
	6.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0	0.3			
6.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0.2				
Total		0.1	0.4	0.8	1.6	2.8	4.7	7.3	9.5	11.1	11.5	10.9	10.2	8.6	7.0	5.1	3.8	2.2	1.1	0.5				

- 1) 7% occurrence above H_w 4m >> Cut-Off
- 2) Average Wave power flux without cut-off = 53.2 kW/m
- 3) Average Wave power flux with cut-off = 33.7 kW/m

Case Study

DRAKOO TYPE-X 6.9MW_p WEC ARRAY (PATENT APPLICATION IN PROGRESS)

Design Dimensions

Type	Drakoo-B Array in X Shape		
Dimensions	Dia. 197 x 12.1	m	
Water Draft	9.3	m	
Lightship Weight	5,880	MT	
Array Peak Capacity	6.900	MW	

Design Conditions

Nominal Significant Wave Height	2.00	m
Maximum Cut-off Wave Height	4.00	m
Optimal Design Wave Period T _z	8.0	sec
Optimal Wave Length L	100	m

Case Study

DRAKOO-X WEC ARRAY PERFORMANCE

Cost-Effective Design Option

Power Output

Drakoo-Module Power Capacity (peak)	75	kWp
Number of Modules in the Array	92	#
Array Power Capacity (rms)	4.60	MW
Array Power Capacity (peak)	6.90	MWp

Electricity Production

Annual Energy Production of Array	11,300	MWh
Annual Average Power Output	1.3	MW (rms)
Capacity Factor / Load Factor	28	%

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Live Demo. via the Internet

DRAKOO - Energize the Future with Ocean Waves

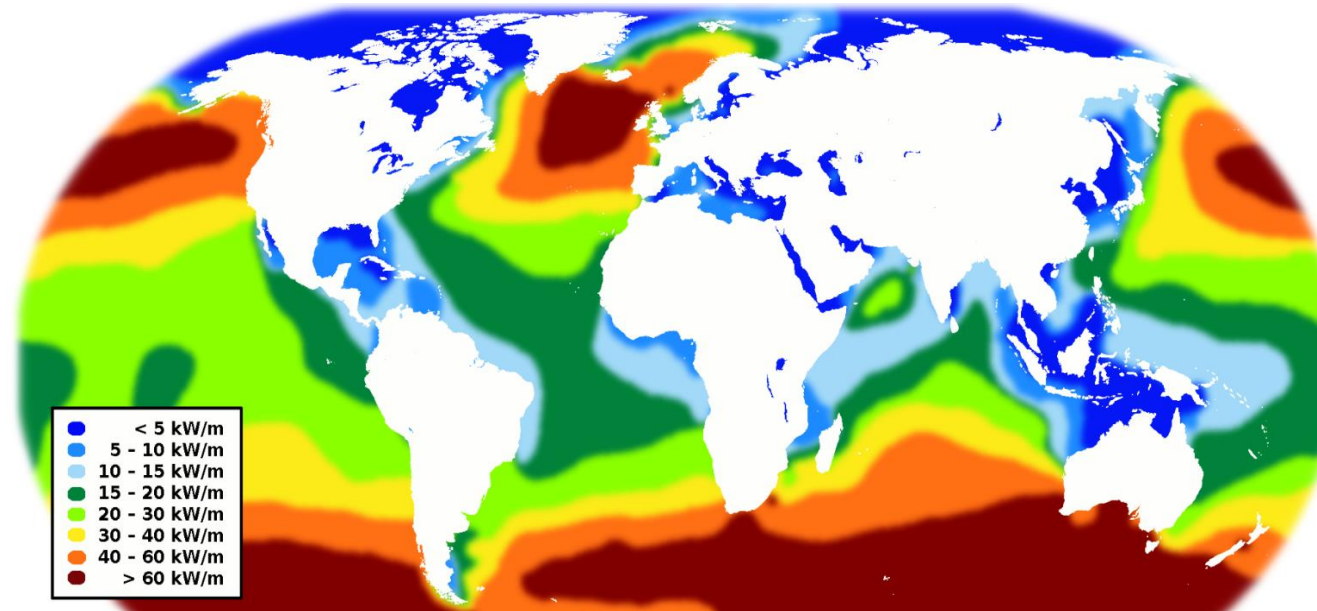


THANK YOU!

For more information, please

- ❖ Visit us at Booth #5008 in WFES2018
- ❖ Visit our website at www.hann-ocean.com
- ❖ Email us at enquiry@hann-ocean.com

COST OF ELECTRICITY PRODUCED BY DRAKOO



Wave Flux	Drakoo Flux	Annu.A. Power	Unit Capacity	Cost of Electricity
kW/m	kW/m	kW	kWp	USD/kWh
12.5	2.6	7.8	15	0.16
17.5	3.6	10.8	15	0.12
25	5.2	15.6	20	0.096
35	7.3	21.9	25	0.077
50	10.4	31.2	35	0.068

Note: Above is based on a total installation capacity of 15MWp for local consumption.