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MERMAID POWER CORP.
empowering lives in harmony with nature
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UPDATE ON MERMAID POWER'S NEAR SHORE WAVE ENERGY UNITS

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ABSTRACT

This update covers key strategies in the manufacture and deployment of Mermaid Power's near shore small wave electrical generator system near Vancouver Canada. Substantive aspects of the wave system design, fabrication, protection and connection to the grid will be presented along with a short demonstration video. Public uptake of the deployment of a wave energy unit in an island community is reviewed. Future viability of the business is supported by an energy cost comparison, power purchase options and the benefits of a local "distributed" manufacturing model.

KEYWORDS: Wave Energy, Net Metering, WEC, Power Optimization, Tidal Compensator, License, Partner, Local, Manufacturing, Maintenance, Low Technology, Training, Financial Incentives, Mermaidpower.com, Cost of Energy per Megawatt, mWh, Detailed Point Absorber Movement Due To Wave Action, Halibut Bank, Wave Energy Formula

INTRODUCTION

Mermaid Power Corp's. mission is empowering lives in harmony with nature.[1] Our goal is to become the leading provider of near shore practical power from wave energy in the 25 to 100 kW field.

Worldwide wave energy has been reported [2, 3] to be sufficient to provide all the power needs for the world. In comparison to solar energy [4] in the populated northern latitudes (New York , London, Berlin, Beijing, etc.) wave energy has 5 times [5] more energy producing hours per year. In comparison to wind, water is 784 times [6] more dense than air. Waves are slow moving with under estimated strong forces.

Our cottage on Keats Island prompted our interest in small scale wave energy devices to utilize the potential of the abundant wave energy available at this location. We expected to purchase a home scale renewable energy wave system like those using solar or wind but none were available for purchase.

OPPORTUNITY

The lack of a wave device for purchase, the competitive cost of wave energy, the abundance of free wave energy throughout the world near large populations, the variety of power purchase agreements, the demand for augmentation to power grids, the need for alternatives to big oil and manufacturing distribution options are the impetus for Mermaid Power's Wave Energy System.

WAVE SYSTEM

We are providing the commercialization of wave energy with the following solutions:

- By working, initially, with small waves in near shore locations to gain small scale acceptance of the technology.
- By using a point absorber system which absorbs wave energy omni-directionally offering greater deployment flexibility.
- By locating the generator and the WEC (the Wave Energy Converter) completely out of the water and above the motive float in an enclosed dome compartment, facilitating ease of maintenance and reduced exposure.

- By developing and fabricating a new more efficient, patented WEC system.
- By building a custom made proprietary axial flux permanent magnet alternator designed for the local wave profile with respect to our WEC.
- By tuning the operation of the generator to optimize the power output in real time (from the power available in a series of waves) using a proprietary program.
- By developing and fabricating a new more efficient patented tidal compensator.
- By developing, fabricating and patenting parts of a semi-submersible vessel which is not attached to the seabed with a pile but it is submergible to suit tidal compensation requirements.
- By completing the electrification process with a grid-tie under the local net metering program
- By ensuring our IP is protected with patents internationally [7] .

Image 01 – Mermaid Power's Wave Machine

View from Below

Image 02 -- Mermaid Power's Wave Machine

Sea Trial Test

Image 03 -- 30 Second Video of Mermaid Power's Wave Machine

Available at www.MermaidPower.com Lower Home Page

SEA TRIALS

A challenge we are having is obtaining a reliable formula to determine the energy in a given wave profile that we can use to size the motive float and the generator with respect to power, frequency and generator optimization. Table 1 gives a summary of the available wave energy of the test site from Environment Canada records.

SUMMARY OF HALIBUT BANK WAVE DATA Station No. 46146 Canada 2013							*mermaidpower.com*		
Simple W. Height Average	Smple W. Period Average	Proportioned Hours (by %) T. = 8,766	Hours per Section	New Avg **Height** WEIGHTED	New Avg. **Height** WEIGHTED	New Avg. **Height** WEIGHTED	New Avg **Period** WEIGHTED	New Avg. **Period** WEIGHTED	New Avg. **Period** WEIGHTED
Meters	Seconds	Hours	Hours	Meters	Meters	Meters	Seconds	Seconds	Seconds
0	0	119	119	Yellow =			Yellow =		
0.1	**3.7**	2,925	2,925	**0.100**	Yellow & Green =		**3.703**	Yellow & Green =	
0.2	**2.9**	1,811	33%	Green Only =	0.264	Yellow	Green Only =	3.365	Yellow
0.3	**3.0**	1,220	5,338	0.354	**0.3**	& Green	3.179	**3.4**	& Green
0.4	**3.3**	886	61%	**0.4**		& Beige =	**3.2**		& Beige =
0.5	**3.4**	743	Y & G =			0.295			3.399
0.6	**3.8**	415	8,263		Green & Beige =	0.3		Green & Beige =	3.4
0.7	**4.0**	263	94%		0.394			3.244	
0.8	**4.1**	137		Beige Only =	**0.4**		Beige Only =	**3.2**	
0.9	**3.3**	94	384	0.957			4.147		
1.0	**4.5**	58	4%	**1.0**			**4.1**		
1.1	**4.6**	40	G & B =						
1.2	**4.8**	27	5,722						
1.3	**5.0**	14	65%						
1.4	**5.2**	8	Y & G & B =						
1.5	**5.4**	4	8,647						
1.7	**5.2**	2	99%						

Table 1 - Summary of Halibut Bank Wave Data, Environment Canada Station No. 46146 for 2013

We need to calculate the vertical energy component in waves from data available from Environment Canada which is simply: wave height and wave period on a per hour basis. The formula: F=.5Hs^2*Te (where F= Force in kW/m wave crest, Hs= Significant Wave Height in m 60% of time and Te=Wave Period in seconds 60% of time) does not allow for a flexible nor detailed analysis of the wave energy available to various motive float configurations. Our wave tank model testing of different weighted motive floats has revealed a motive float energy profile that includes possibilities of different forces during the movement of the motive float: for the upward heave period, the crest period the downward heave period and the trough period. See Diagram 1 - Detailed Point Absorber Movement Due To Wave Action.

We plan to attempt finding these force values acquired by a motive float of specific size and design and frequency, from specific waves measured on a wave by wave basis with a transducer, firstly, by measuring the force directly and secondly, calculating the force using the electricity produced from our generator and inverter optimizer, and using the calculated friction and mechanical aspects of our known WEC.

The sea trials scheduled for Q1 2015 will be instrumental in providing this and much other data.

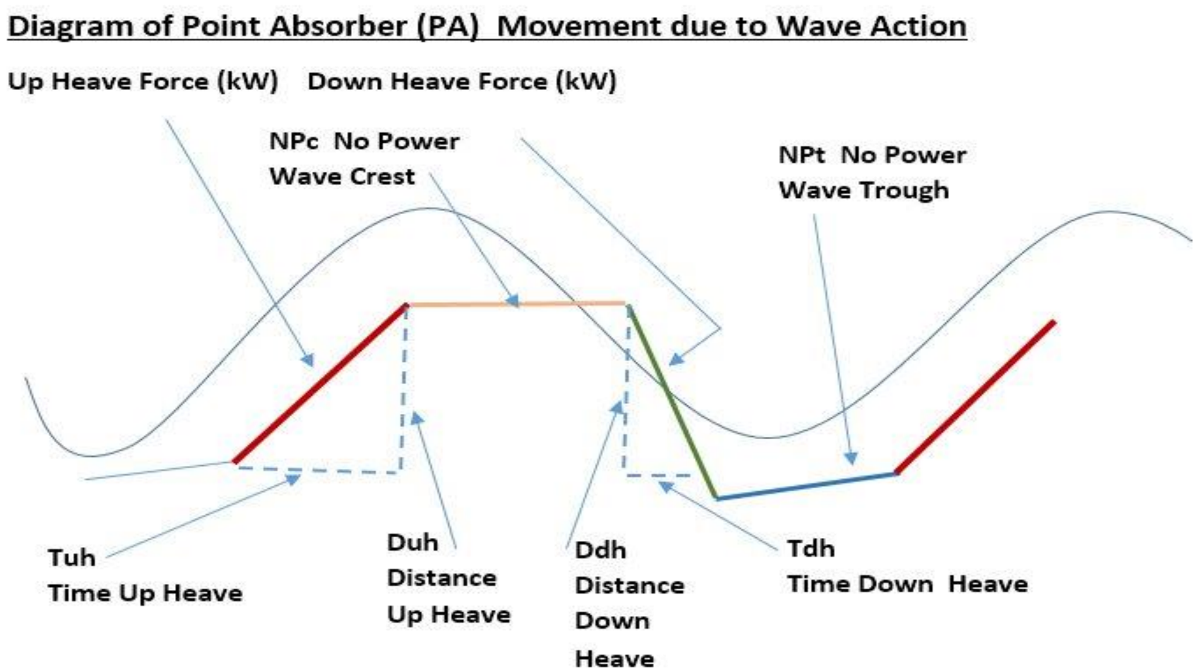

Diagram 1 – Detailed Point Absorber Movement Due To Wave Action

PUBLIC UPTAKE.

Public uptake of emerging technologies are always interesting. We approach the wave machine public deployment with a spirit of co-operation and full honest disclosure whilst conforming with regulations and respectful for bodies of concern, such as: islands trust, intertidal zone issues, environmental concerns particularly with respect to the plant and animal interconnectedness.

We have openly discussed the wave energy project with our neighbours, (the permanent and seasonal residents of Keats Island) over the past 4 years so the deployment and trial operation of the unit will not be something of a surprise and instead may be considered as an effort that engenders community pride.

Initially we obtained a foreshore lease and obtained permission from the provincial government to deploy a wave energy system on the leased seabed. Our intention was to attach the unit to a pile, however, Fisheries and Oceans Canada periodically closes this location, and others, to any marine activity such as pile driving so we had to find an alternative method that would allow unrestricted, in terms of time of year, access to wave machine deployment.

The solution is to build, license and operate a commercial vessel under the Transport Canada federal regulations. Registration includes the marine navigation safety requirements for radar deflector, all-around light for night time and the international black ball moorage symbol for day time observation. It is a non-powered semi-submersible vessel registered with a "C" license that will be moored in various locations beginning with moorage on the foreshore leased seabed at Keats Island and then moved to alternate locations to allow for broad spectrum testing in waters with varying wave activity and public uptake. International regulatory environments would allow for similar vessel registration arrangements.

Under and above water video documentation has been installed to record the real time interaction of waves around the motive float, and any foreign objects and occurrences that could interfere with the operation of the apparatus.

It is important to realize that the average frequency of waves, as reported by Environment Canada in this area, is 3.4 seconds, thus the movement of the float is very slow and the flow of water from this movement is always away from the float on both the up and down strokes.

Any problems found will be addressed through remediation of the unit's underwater areas. It is our intention to make this video available on the mermaidpower.com web site.

Active Earth Engineering Ltd. has been hired to prepare a report on the environmental impact of the materials used in the construction of the unit. All the products used on the system are used in boat and marine construction and coatings, which meet or exceed current codes.

We will participate in local environmental group activities and will provide information and demonstrations to the local residents. The initial site is near a well travelled kayak, paddle board and rowboat route in the summer months.

The design of the unit has been carefully considered. Aesthetically the unit is designed to blend with the ocean and scenery. The exterior has been designed to mitigate tampering and boarding and considers all reduction of risk for public safety.

The visual and physical impact of this unit in the water is similar to that of a 25 foot boat tethered to a mooring buoy.

BUSINESS CASE

ENERGY COST COMPARISON

Investors often ask what is the "cost per watt" [8] for the installed wave system and then compare that to a rule of thumb value of $2 to $3 per watt derived from the cost for installed solar systems.

We have found that this method of comparison works more fairly in the renewable energy sector when the number of watts per year for each system is compared rather than the original "peak watts" which assumed a continuous year round power production

In Korea [9] and Ontario [10] Canada two monitored solar systems were compared as to average number of energy producing hours per year. In both cases solar energy systems yield slightly more than 1,200 hours per year.

In the Georgia Strait, British Columbia, the Environment Canada wave data [5] records slightly more than 6,000 hours per year with waves greater than 20cm height (peak to trough). The Mermaid Power wave energy unit is expected to produce 25kWh in waves over 20 cm height.

So in terms of comparing watts per year from solar and watts per year from waves it is found that waves produce approximately 5 times more watts per year than solar.

Therefore, a cost of $10.00 per watt for installed wave systems (yielding 6,000 energy production hours per year) is the same as a cost of $2.00 per watt for installed solar systems (yielding 1,200 energy producing hours per year). [11]

Another metric used to compare energy costs is $ per mWh. BC Hydro [12] estimates that the unit energy cost for tidal power ranges from $264 to $581 per megawatt hour, compared with $115 to $365 for onshore wind power. It is understood that this assumes a 20 year life time.

In the case of Mermaid Power's 25 kWh unit we calculate a cost of $100 to $150 per mWh.

It has been calculated [13] that the cost for energy from the proposed BC Hydro Site C dam, costing upward of $ 10 Billion, will be in the $50 to $80 per mWh range.

A comparison of cost of electricity by source [14] in the UK 2010 and Germany 2013 is provided in note 14.

POWER PURCHASE OPTIONS

A variety of power purchase opportunities exist to increase the incentives to develop and utilize renewable energy which shape the business models in specific locations around the world. These agreements can generally be categorized as: Independent Power Purchase, Feed In Tariff and Net Metering. In the Province of British Columbia, Canada, the best option is the BC Hydro Net Metering Agreement for which we have been approved.

It is interesting to note that the BC Hydro recently increased its total capacity for their Net metering program to 100 kWh, to bring it line with other existing international net metering programs.

Our objective was to prove that the Mermaid Power wave energy system worked: from using wave energy as the prime mover to generating revenue from a third party power company for power produced to their standards.

We found that the Net Metering Program is ubiquitous in most jurisdictions and that the main issues are:

- The owner of the property the meter is on must own the energy device.
- The rectifier and inverter must meet the CSA - C22.2 N. 107.1-01 standard. [15]

- The installation is simply done under local permit by a certified electrician and includes a disconnect switch which automatically disconnects the power flow to the grid if the grid is not live.
- The solar and wind industries have years of experience and specialized systems for enabling safe grid tie-ins.

DISTRIBUTION OPPORTUNITIES

Traditionally, manufacturing is centralized and products are shipped globally. We [16] looked at this model and determined that in the case of the emerging wave energy industry a distributed manufacturing model would be more acceptable for the following reasons.

- Takes advantage of local incentives.
- Capitalizes on all local resources, including materials and labour.
- Provides local employment and education.
- Regulatory and environmental issues unique to the locality would be dealt with first hand by locals, without interpretation.

For these reasons we have concluded that building the wave energy units in different countries, possibly through a licensing-partner program, will enable local entrepreneurs to avail themselves of local financial incentives, to provide original equipment manufacturing and to train people in equipment usage and maintenance, has more benefits (both cost wise and socially) than a central manufacturing and distribution model.

CONCLUSION

Small scale near shore wave energy systems are viable. The technical innovations in the design and implementation of Mermaid Power's Wave system offer solutions to create scalable wave energy units and new options for renewable energy worldwide.

ACKNOWLEDGEMENTS AND REFERENCES

1. Christopher Ng, 2014, for this phrase and other business assistance from conversations, sit down meetings and thoughtful consideration.
2. ASSESSING THE GLOBAL WAVE ENERGY POTENTIAL, 2010 Proceedings of OMAE2010 29th International Conference on Ocean, Offshore Mechanics and Arctic Engineering, June 6-11, 2010, Shanghai, China.
3. Thorpe, T.W. 1999, Approximate Global Distribution of Wave Power Levels (Figure 1) in AN OVERVIEW OF WAVE ENERGY TECHNOLOGIES: STATUS, PERFORMANCE AND COSTS
4. Charles Haynes has extensive experience in the field of solar energy having built 3 solar houses at UBC used for student housing, been responsible for over 100 solar houses built and published in the field:
    a. Haynes, C., 1981, US Patent 4,270,519, Solar Heating System.
    b. Haynes, C., 1979, SELF HELP SOLAR HOUSING, University of British Columbia.
    c. Haynes, C., 1982, NET SOLAR TRANSMITTANCE FACTORS: a Z-80 OASIS OS program, Camosun College, Nanaimo, BC.
    d. Haynes, C, 1984, ACADIA SOLA HOUSE PLANS, Canadian Self Help Housing Association.
5. Environment Canada, 2008- 2013, ANNUAL WAVE DATA Halibut Bank Buoy No. 46146
(Georgia Strait, British Columbia) records slightly more than 6,000 hours per year with waves greater than 20cm height (peak to trough). The Mermaid Power wave energy unit produces 25kWh in waves over 20 cm height.
6. 1000 kg/m^3 (density of water) divided by 1.275 kg/m^3 (density of air) yields 784. Therefore, at sea level, air is 784 times less dense than water.
7. We have completed a PCT (Patent Cooperation Treaty) Application.
8. In conversation with Mike Volker, at Keiretsu Angel Investment Forum, November 2013, when he offered to demo a Mermaid Power Corp's. wave energy power plant at his West Vancouver water front home.
9. In conversation with of Dr. T.Y. Lee of KC Green Holdings Co., Ltd., a Korean businessman we met at the Globe 2014 Conference, Vancouver Canada.
10. In conversation with Dr. Peter Vander Zaag, January 2014, Owner of a 250 kWh solar system in Ontario Canada.
11. Ibid, Vander Zaag, Peter, Dr. October, 2014:
the cost was approximately $3.00 per watt [10] for a 250kW system that has a Feed In Tariff 1.0 Rate of $0.71 / kWh guaranteed for 20 years and

currently (2014) is approximately $2.00 per watt [11] for a system with a guaranteed 20 year Feed In Tariff 2.0 Rate of $0.54 for a 250kW system;

So $2.00 / watt for solar at 1200 hours / year = $10.00 / watt for wave system which produces 1,200 * 5 = 6,000 hours per year of energy production.

12. Bruce Constantineau, 2014, THE VANCOUVER SUN, newspaper article: Energy "Tide-powered turbine will feed electricity to B.C. fishing lodge", October 29 edition:

    - "BC Hydro's proposed $8-billion Site C dam in northeast B.C. would generate about 1,100 megawatts of power."

    - "Hydro estimates the unit energy cost for tidal power ranges from $264 to $581 per megawatt hour, compared with $115 to $365 for onshore wind power.

13. Author Note:
    - Power cost at Site C Dam will be in the $80 per mWh based on the following assumptions: Time period = 20 years, Cost overrun of project = $5 Billion, Annual maintenance costs = $10 Million.

    - Power cost at Site C Dam will be approximately $50 per mWh if total cost for 20 years operation = $8.36 Billion, see note 12 above.

14. Cost Of Electricity By Source UK 2010 and Germany 2013 Reported in Wikipedia with Conversion to USD by Author, Please SEE NEXT PAGE

15. The Rectifier and Inverter made by Power One, now owned by ABB, meet the CSA - C22.2 N. 107.1-01 standard as well as UL 1741, and IEEE 1547 standards.

16. In conversation with Richard W. Evans, MBA, CBV, ASA, RwE Growth Partners, Inc. during business plan and marketing discussions, June 2013 concerning Mermaid Power Corp.

Tables, Diagrams, Images and Videos

From WIKIPEDIA (Accessed: Oct 29, 2014) Cost of Electricity by Source

UK energy costs for different generation technologies in pounds per megawatt hour (2010)

Technology	Cost range (£/MWh)[citation needed]	Cost in USD $ Per mWh
Natural gas turbine, no CO_2 capture	55 – 110	**88 – 176**
Natural gas turbines with CO_2 capture	60 – 130	**96 – 208**
Biomass	60 – 120	**96 – 192**
New nuclear	80 – 105 (92.50 guaranteed from 2023[22][23])	**128 – 168 (148)**
Onshore wind	80 – 110	**96 – 176**
Coal with CO_2 capture	100 – 155	**160 – 248**
Solar farms	125 – 180	**200 – 288**
Offshore wind	150 – 210	**240 – 336**
Tidal power	155 – 390	**248 -- 624**

Exchange Rate: 1 Pound = $1.6 USD

Germany energy costs for different generation technologies in EUR per megawatt hour (2013)

Technology	Cost range (EUR/MWh)	Cost in USD $ Per mWh
brown coal	38-53	**48 – 67**
hard coal	63–80	**80 – 101**
CCGT power plants	75-98	**95 – 124**
onshore wind	45-107	**57– 136**
offshore wind	119–194	**190 – 246**
PV power plants	78-142	**99 – 180**
biogas	135–250	**171 – 317**

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SLIDES FROM POWER POINT PRESENTATION

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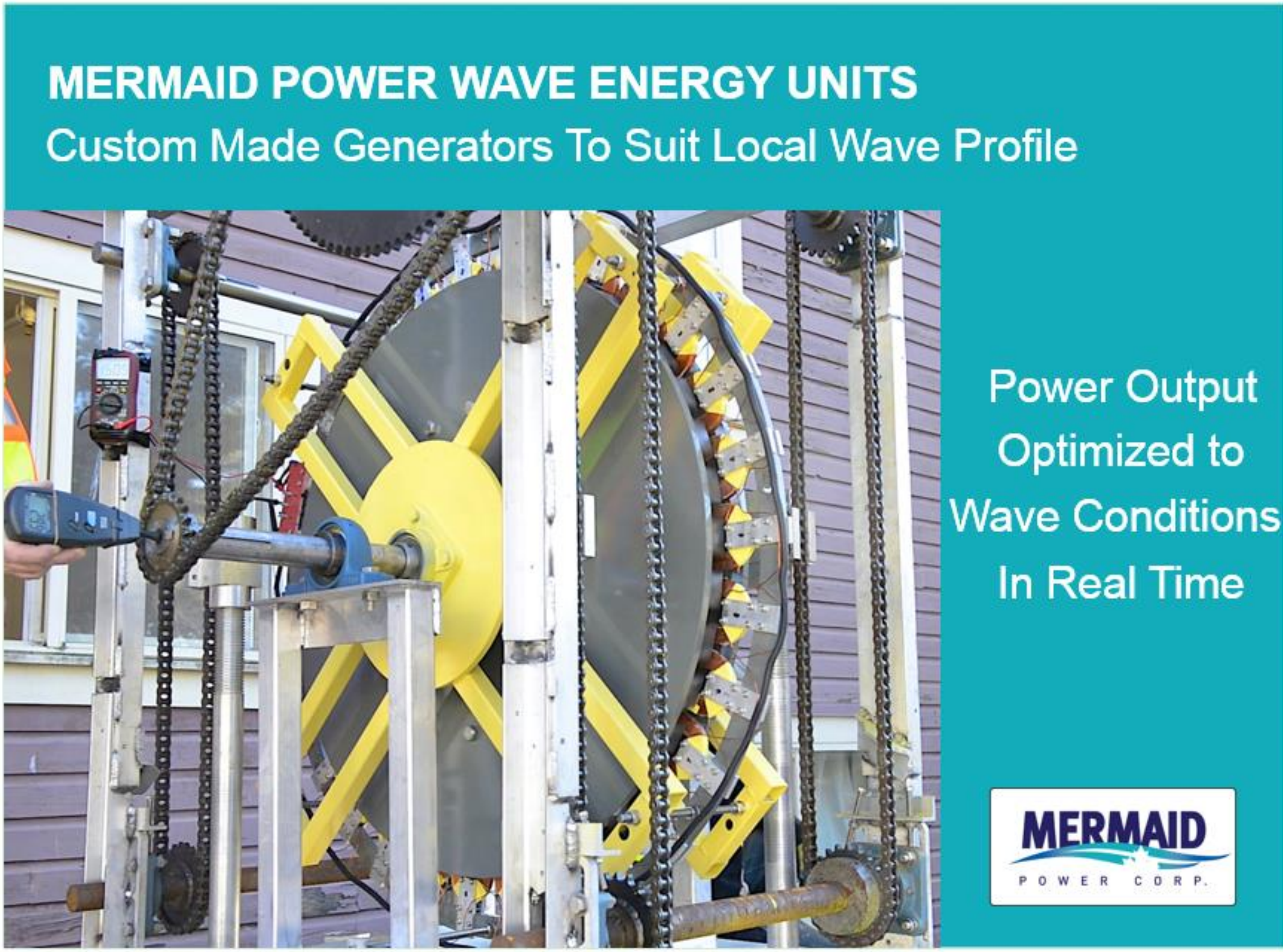
Wave System *(4 patents – PCT)*

- Built to last 6 months & learn a lot
- 25kW from small near shore waves
- Point Absorber - all-direction waves
- WEC = push rod –chain–one way clutch
- Generator Custom made
- Power Optimization in real time
- WEC & Gen above water in Dome
- Tidal Compensator System
- Semi-Submersible vessel – registered
- Grid Tie-in via net metering (ABB)



VIDEO 1 – 2 Minute Video of Mermaid Power's Wave Tank Test of Generator

VIDEO 2 – 30 Second Video of Mermaid Power's Wave Machine

Available at www.MermaidPower.com Lower Home Page or in IOCE 2014 section

Public Uptake

- Approach
- Licenses
- Report
- Design

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Business Case

- Energy Cost Comparison (8,700 hr/yr.)
  - **$ / Watt**

Comparison by number of E. production hr/yr.
Solar in N. latitudes 12-13% = > 1,200 Hrs
Wave in N. latitudes 70-85% = 6,000 – 7,500 Hrs

Waves at least 5x: $2/w Solar = $10/w Waves
25kw system @10/w = $250,000 actual = $125,000
Hence cost is $1.00 / watt= very competitive.

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Business Case

- Energy Cost Comparison (8,700 hr/yr.)
  - **$ / mWh**

Comparison by total E. produced over 20 years

25 kW @ 6000 hr/yr. * 20 yr. = 3000mWh total
Cost 125,000 + (10,000 *20) = $ 325,000
Hence: $ 108 per mWh

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Business Case

- Energy Cost Comparison

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