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PRODUCTION OF POWER USING WIND AND WAVE ENERGY COMBINDLY

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Abstract-*This paper proposes a system to combine and utilize multiple turbines power. In this system wind and water turbine combinedly used to produce mechanical energy by a number of turbine to regulate a single generator . Collected mechanical energy of rotors spinning by the effect of velocity of water and wind will converted into hydraulic pressure by the help of input piston. The hydraulic pressure gained from multiple set up of rotors can be collected in an active hydraulic pressure chamber. By using interchanging valve this pressure consecutively transferred to the output piston. So the output piston will work to rotate the shaft generator. This mechanical energy is converted into electrical power. As a single generator is used for multiple set up of turbines rather than a number of generators, it is cost effective which the main concern of this proposal is.*

Keywords: Wind turbine, Attenuator, Hydraulic pressure, Interchangeable valve, Turret mooring

1. INTRODUCTION

Now a day's worldwide energy crisis is one of the great problem. The interest in renewable energy has been revived over last few years, especially after global awareness regarding the ill effects of fossil fuel burning. The use of renewable energy technology to meet the energy demands has been steadily increasing for the past few years, however, the important drawbacks associated with renewable energy systems are their inability to guarantee reliability and their lean nature [1]. Renewable energy sources are considered to be the better option to meet these challenges and wind and wave energy will be the most suitable sources. In this paper we will present a system to use wave and wind energy combindly and efficiently.

About 70% of the earth is covered with water. Experimental works show that along with the wave energy deep sea and costal area is a great source of wind energy .Figure 1 shows integrated model satellite and in-stu measurements providing quality wave and wind data [2]

[---time----][------overall-------------][------wind sea-----][------swell--------][-----wind-----]

year mm ddhh SWH MDIR PP1D MWP SHWW MDIRW MPWW SHPS MDIRS MPPS WINDSP WDIR

2006 11 19 12 1.53 152.6 4.95 5.62 1.29 157.3 4.36 0.82 61.6 8.31 10.17 157.3 35.0

2006 11 19 18 1.45 158.1 5.21 5.47 1.28 159.2 4.52 0.69 9.4 8.17 9.90 159.2 38.5

2006 11 20 0 2.02 166.4 6.30 5.91 1.88 162.5 5.44 0.74 228.8 8.11 11.54 162.5 42.0

2006 11 20 6 2.29 169.0 6.30 6.09 2.16 165.7 5.69 0.78 225.7 8.33 12.55 165.7 45.0

2006 11 20 12 2.51 176.6 6.89 6.26 2.40 175.0 5.92 0.72 242.3 9.00 13.35 175.0 48.0

2006 11 20 18 2.26 181.7 6.58 6.23 2.15 177.4 5.71 0.71 261.2 9.66 12.05 177.4 51.0

2006 11 21 0 1.78 195.8 5.73 6.04 1.66 185.4 5.10 0.64 275.6 10.54 11.96 185.4 54.0

Fig. 1: Integrated model satellite and in-stu Measurement providing quality wave and wind data

From the world map we can also see the wave energy potential at the specific site shown in Fig. 2

Fig.2: world scenarios of energy potential at the specific site

The benefits of adding a wave energy device to a floating support structure for a wind turbine is stability and the boat landing. The wave energy device absorbs the wave motions, and thereby makes the structure even more stable. According to FPP, 70-90 percent of the energy in the wave motion is absorbed into a controlled system. This provides stability compared to a normal floating structure without any absorption.

And because of the absorption of the motion energy of the waves, there will always be calm waters at the rear of the structure – a lee side, where boat landing on the structure is possible in harsh weather. See the second picture below for an illustration of this.

From the other point of view, the benefits of adding one or several wind turbines to a floating wave energy device are stability and increased production. Measurements from the prototype Poseidon have shown that the pressure from wind on the turbines stabilizes the structure in the water, and this stability increases the power output of the wave device by 1-2 percentage points.

And since the wave energy device provides a floating support structure anyway, the cost of establishing wind turbines offshore in this system corresponds to the expense of establishing the turbines onshore.

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2. MODEL SET UP

Model will be set up in deep sea. When combining wind and wave energy devices, the support structure acts as a semi submerged device. Semi-submerged structures are sometimes referred to as barge floaters.

The wind turbines are defined by the height of the tower. This height is determined by the dimensions of the support structure. The larger the platform size, the higher the tower height. The turbines can be either of the upwind or downwind type carrying one, two or three blades on the rotor. Depending on size and shape the number and power of wind turbine will be varied. The wave energy will be captured using attenuator method. The support structure is secured using a turret mooring system shown in Fig. 3.

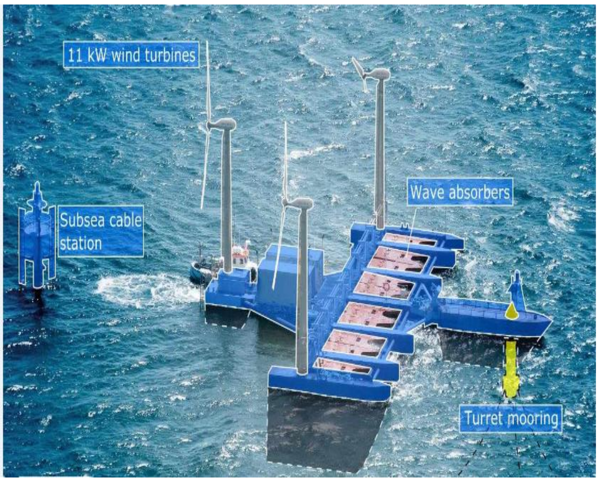

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Fig. 3: Turret mooring system

2.1 Attenuator

This is a long floating device which is aligned perpendicular to the wave front [3]. The device effectively rides the waves and captures the energy as the wave moves past by selectively constraining the movements along its length. A current example for the attenuator is the Pelamis device, earlier shown in Fig. 4.

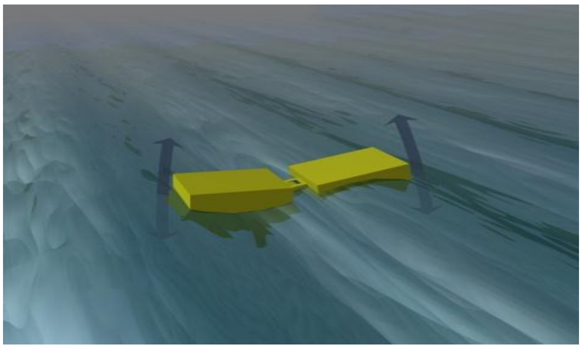

Fig. 4: Photograph of Pelamis attenuator

2.2 Turret Mooring

With a floating structure that turns towards the waves, an anchor system which allows full 360 degrees rotation is needed [4] Turret mooring is widely used on so-called FPSO (Floating Production, Storage and Offloading). The turret is in its essence a buoy held in place by three or more mooring lines. The mooring lines are secured with anchors. The mooring lines have enough slack for the turret to move up and down when water levels rise and fall – but because of the number of mooring lines, the horizontal position remains the same with little deviation. Thus, a platform installed at more than 40 meters depth will be able to follow a rise in the sea level of up to 30 meters.

The system is not suited for depths less than 40 meters because of the energy in the waves at low depths. It would not be commercially viable.

3. POWER PRODUCTION

3.1 Power Production Through Wave

The wave absorbers convert the forward and upwards pressure from the waves to an upward and downward motion. The movement of the floaters drives a double piston pump on each flow, pushing water at high speed and pressure through a turbine.

3.2 Wave power formula

In deep water where the water depth is larger than half the wave length, the wave energy fluxes Equation (1)

$$P = \frac{\rho g^2}{64\pi} H^2 T \approx (0.5 \frac{kW}{m^3 .s}) H^2 T \qquad (1)$$

Where P indicates the wave energy flux per unit of wave-crest length, H is he significant wave height, T the wave period, ρ is the water density and g the acceleration by gravity. The above formula states that wave power is proportional to the wave period and to the square of the wave height. When the significant wave height is given in meters, and the wave period in seconds, the result is the wave power in kilowatts (kW) per meter of wave front length [7]

3.3 Power Generation

[5]Based on public domain information and after discussions with the device developer the characteristics of the 750 kW prototypes were scaled up to represent anticipated future machines. 1. Semi-submerged, cylindrical structure consisting of 5 segments and 4 power modules, 180 m long;
The device parameters used for the study were:
1.5 MW rated power, power limitation through inherent design characteristics;
Water depth range 50 to 150 m;
Passive device alignment > ±90°;
Packing: 3 rows of devices with 12.5 to each 1 km^2 cell (18.75 MW/km^2 capacities).

Figure 5 shows the power-matrix of the notional wave energy converter. Each entry in the matrix gives the generated electrical power in kilowatts for a particular combination of parametric wave height and period. The combinations of H rms and T e values cover the full range of values found in the data records.

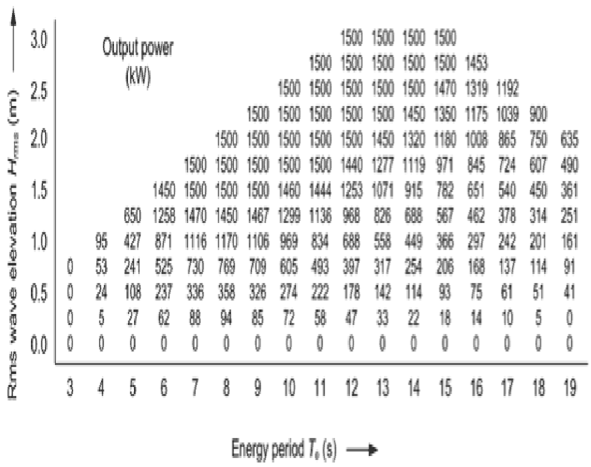

Fig. 5: Power matrix of national wave energy converter

3.4 Production of Energy through Wind

Apart from the waves, the rest of the energy comes from the three wind turbines. The size and power of the turbines are chosen according to a single criterion: tower height. The surface area and weight of the platform defines how high the tower can be. And the tower height defines what turbines are available on the market. A common wind turbine is onshore wind turbine [6]. Instead of a standard lattice tower, a tubular tower was chosen to improve corrosion protection. The turbine can be upwind or downwind, and fitted with any number of blades. Only the tower height matters. In fact, the turbines have been proved to stabilize the whole construction at sea.

3.5 Wind Turbine System

In a wind turbine system, the kinetic energy in the wind is converted into rotational energy in a rotor of the wind turbine. The rotational energy is then transferred to generator, either directly or through a gearbox for stepping up the rotor speed. The mechanical energy is then converted to electrical energy (variable-frequency, variable-voltage) by the generator. From the generator, the electrical energy is transmitted to a utility grid either directly or through an electrical energy conversion stage that produces constant-frequency, constant-amplitude voltage suitable for interface to the utility [7].

3.6 Wind Power Class

The wind power class is a number indicating the mean energy content of the wind resource. Wind power classes are based on the mean wind power density at 50 meters above ground [1]. According to the Wind Energy Resource Atlas of USA, wind power class distributions are shown below in Table 1 [8].

Table 1: Wind power class

Wind Power class	Description	Power Density at 50m (w/m^2)
1	poor	0-200
2	marginal	200-300
3	fair	300-400
4	good	400-500
5	excellent	500-600
6	outstanding	600-800
7	superb	800-2000

3.7 Combining The Two Power

In this concept we will collect the mechanical energy of Rotors spinning by the effect of high velocity river, into the hydraulic pressure by the help of input pistons. The hydraulic pressure gained from multiple set-ups of wind turbines and wave can be collected in an active hydraulic pressure chamber. By using the interchanging valves this pressure can be consecutively transferred to the output pistons. So the output piston will work to rotate the shaft of generator. As a result we will have large numbers of rotors to utilize the sum of their mechanical force. We will need to install only two appropriate size generators for higher output. This theme can cut the cost of many small scale generators and instead of installing a row of generators we will have to install only two generators shown in Figure 6.

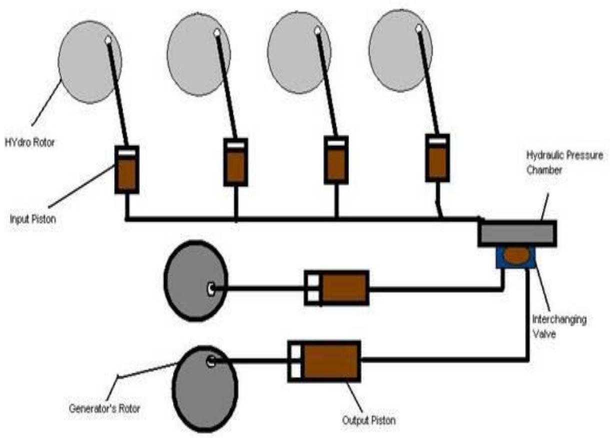

Fig. 6: Arrangements of settings of the generators for power generations

4. CONCLUSION

In this paper we have presented a model to use wind and wave energy effectively and efficiently. The model is mostly feasible at Pacific and Atlantic Ocean between the latitudes 40 and 65 as the most energetic waves is found in there. Use of two generators rather than multiple generators will less the cost 30 to 40 percent. As wind and wave is the source of 4.3 TW energy, it will be our solution of power crisis if we will be able to use them perfectly.

5. REFERENCES

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6. NOMENCLATURE

Symbol	Meaning	Unit
T	Temperature	(K)
Symbol	Meaning	Unit
P	Wave power	KW/m
Hm	Wave height	m
T	Wave period	s
ρ	Density	kg/m^3
g	Acceleration by gravity	m/s^2