Floating Hybrid Wind-Ocean Current Generating Station

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Abstract— The floating wind and current hybrid power generating system can be utilized to convert two renewable energy sources namely the wind energy and ocean current energy into infinite electric power. These inexhaustible power sources are harnessed which provides cost-effective power generation with minimal environmental impact. The project which consists of a either savonius or darrieus wind turbine and savonius current turbine having a floating deck and a dynamo as generating equipment reduces pollution hazardous and helps in reducing power shortage over coastal region.

Key words: Savonius Turbine, Darrieus Turbine, Deck, Anchors, Drag and Lift

I. INTRODUCTION

The dual floating power generating system is capable of generating large power over infinite time period. Its basic idea consists of using two renewable energy sources namely the wind energy utilized to generate electrical power using either the savonius or darrieus turbine and the current energy of oceanic wave to generate electrical power using only savonius turbine. Savonius turbines are two scoop turbines which look like a 'S' shape in cross section [1]. The main advantage of the dual floating power generating system is that it has a vertical axis wind turbine which does not need to orient itself to spin in response to a passing breeze as compared to the horizontal design. It can take full advantage of a wind arriving from any direction and immediately convert this wind into rotation of shaft and turbine resulting into generation of electricity. The project eliminates the construction and foundation cost since it is of the floating types and not actually joined to the floor surface of the ocean. The project is anchored or moored to the ocean surface. One another important part of the generating system being the deck which provides stability to the whole power system as such prevents the plant to fall off due to any sudden abnormal increase in current or high wind pressure with its constructional design.

II. OPERATION

A. Savonius Turbine:

In operation, a Savonius ocean current turbine and a Darrieus vertical-axis or another Savonius wind turbine connect with a central gearbox/generator to generate power from ocean currents and wind both in combination. The Savonius ocean current turbine has split-cylinder-shaped buckets that can harness any weak current [3]. It rotates in one direction regardless of current direction which means even if the direction of wind or current in particular is reversed or if both directions are interchanged, the rotation of the blades will be in the same well defined direction to produce power. Because of the curvature of S-shape turbine, the scoops experience less drag when moving against the wind than when moving with the wind. Differential drag causes the Savonius turbine to spin also the Savonius current turbine acts as ballast, making the floating power generation assembly self-righting. The best operational feature of the power system is that it remains in operation even during when breezes are light, and ocean current is available, the ocean current turbines will rotate which will complement the rotation of wind turbine and generate electric power no matter how less is the wind

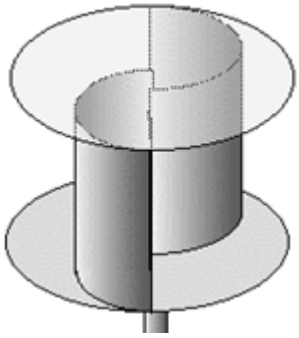

Fig. 1: Savonius Rotor

B. Darrieus Turbine:

Darrieus wind turbine is a three-bladed vertical axis wind turbine(VAWT) which are 120 degrees apart from each other. This turbine consists of 3 aero foils fastened to the same rotating shaft above the deck. This Darrieus VAWT has been modeled to

capture twice the energy compared to its conventional rectangular swept area onshore turbine [2]. Therefore, for the same area it can deliver far more power than a conventional rectangular shaped wind turbine. The unidirectional Darrieus turbine rotates regardless of the wind direction. The challenge with the Darrieus wind turbine design is that it is not a self-starting turbine. This means that it can't generate enough power to start rotating on its own and needs to have a little help to get started which will be provided by the ocean current turbine as it is mounted on the very same shaft or gear mechanism. Most of these styles of turbine use a small motor to start this rotation and then the Darrieus wind turbine will spin on it own as long as a breeze is blowing. However, this challenge in Darrieus turbine is completely avoided by replacing them with conventional savonius turbine. However apart from the self-starting issue, Darrieus turbine provides higher efficiency and more power at breeze difference than savonius turbuine. Darrieus turbines can be used for conditions having low wind pressure and savonius turbine can be used for conditions having high pressure wind.

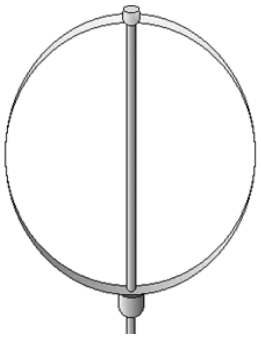

Fig. 2: Darrieus Rotor

III. FEATURES

An important feature of this power system is its self-balancing techniques and its unique blade construction and design. The blade acts much like an airplane wing. When the wind blows, a pocket of low-pressure air is form on the downwind side of the blade. The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to generate electric power in large numbers. The design allows it to survive through rough seas. Its deck-mounted generator and below-deck ocean current turbine provides the platform with a low centre of gravity which provides them to balance itself in worst scenarios. The greatest feature of such plants is its flexible wound mounts which allow it to rock back and forth with waves which prevents from output power reduction during low ocean levels

A. Deck:

A deck is a closed vessel floating semi-submersible platform which consists of a platform for generator and generator`s assembly and shock-absorbent rubber which looks like a circular tub. The shock-absorbent rubber is tightly packed between generating assembly and the deck which results in minimum shock or vibration occurring, due to changes in the wave on the power plant. The deck can be made of either rubber or polished wood or plastic compounds. However, wood degrades as it comes in contact with the water surface. As a result, deck which are made of strong plastic components having a high life is highly recommended

B. Anchoring or Mooring:

As the power plant is floating it is very important to anchor it to prevent the body from drifting due to wind and current waves which is done by connecting the surface of the deck to the bed of water bodies with the help of strong anchors, similarly done for anchoring of ships. Anchoring is done by the rod, which is made of chain, cable, rope, or a combination of them.

IV. BLOCK DIAGRAM

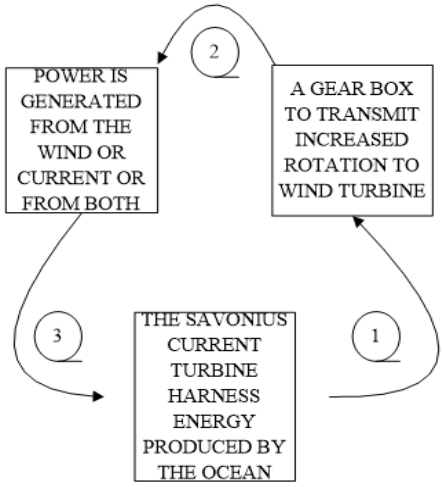

Fig. 3: Cyclic flow diagram of generation [4]

V. ADVANTAGES

1) This turbine is insensitive to marine growth on the buckets and is harmless to the marine life, as it rotates at the speed of the current which doesn't put any marine life in danger
2) Stable performance in an unstable sea is the biggest advantage as the movable power plant can be anchored to the surface of the ocean
3) Another great advantage of such hybrid power plant is that it requires no external power to operate, not even at the initial period of rotation.
4) Once its build, there is no more running cost since the fuel/resources required for electric power production are freely available (wind & ocean current).
5) It produces no greenhouse gases or other waste and do not have a large environmental impact.
6) It produces electricity reliably with cost effective techniques and machinery.
7) Offshore turbines and vertical-axis turbines are not ruinously expensive to build
8) The plant is expected to be in production for 50 to 80 years with a very high efficiency and moderately beyond this tenure.
9) The savonius current turbine is made of plastic material which eliminates the corrosion issue
10) This generating system can be used as a emergency power source over the coastal periphery of the country
11) This generating plant is in operation throughout the year and remains unaffected due to any change in the climate condition.

VI. APPLICATION

Apart from the main application of providing power only to the coastal region another major application of such floating small sized dual power plant is that it can be attached to any huge ships with the help of mechanical assemblies which can be used as a captive unit for providing electric power to the ship's small accessories resulting into reduction of electric load requirement from the initial generating option thus reducing the usage of conventional fuel consumption.

VII. CHALLENGES

1) The strength of the wind is not constant and it varies from zero to storm force. This means that wind turbines do not produce the same amount of electricity all the time. However due to dual energy source utilization, this challenge can be avoided to a greater extent.
2) There will be always a fear of complete destruction of such hybrid power plants occurring due to any natural calamities. However such challenges can be eliminated by migration

VIII. CONCLUSION

The country that uses this system will achieve higher level of accuracy and satisfaction. This technique is rather more beneficial than those already existing techniques for using inexhaustible energy sources. With this certain innovation and advancement, especially for country like India having peninsula region, it is very efficient where there is a possibility of using them throughout the coastal region of India in some upcoming years.

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