Wave Catcher Provides Momentum For Alternative Energy

Barge Turns the Oceans Into Power Source

By Donald Gehring

Marine Energy Corp. (MEC), based in Houston, Texas, has now patented one of the most cost-effective and powerful marine energy systems to date: the Wave Catcher Barge. Engineering has shown that one barge should be able to power four large wind turbine-type generators. These barges can be installed almost anywhere and in almost any water depth, making the oceans our next power source of choice.

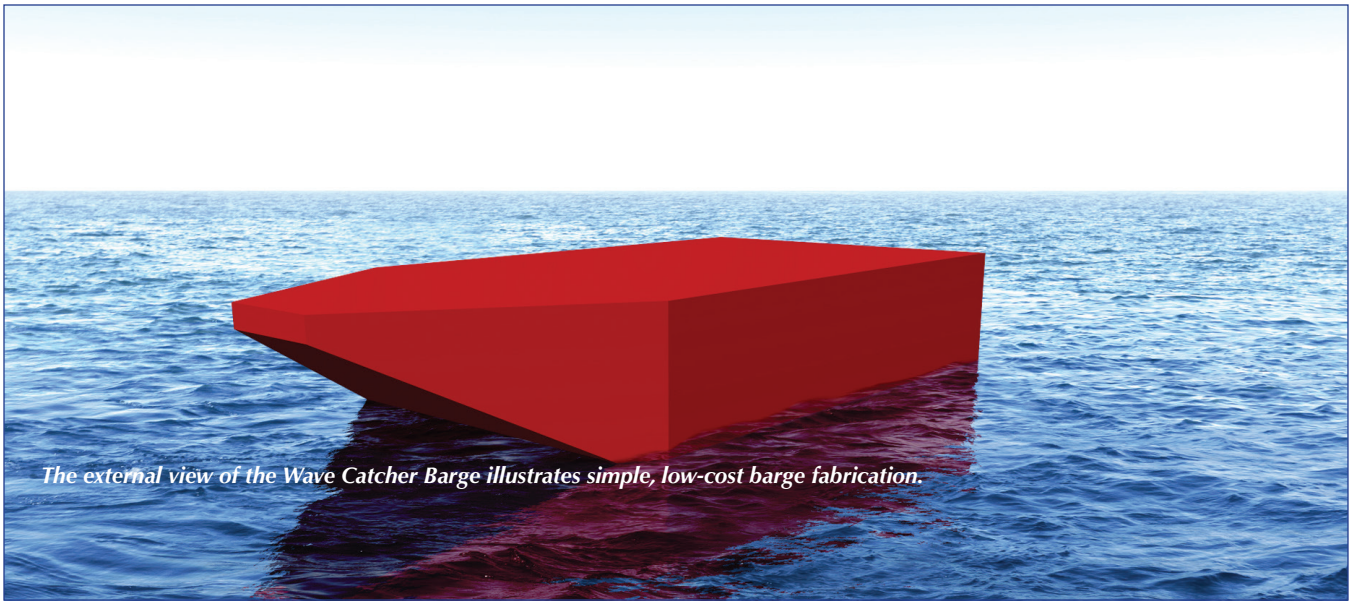
The Wave Catcher Barges can be installed in shallow to ultradeepwater, as stand-alone generators for small communities with relatively low power needs or in large power farms taking advantage of the economies of scale. In a large power farm, each barge can export its power through draped, flexible power cables to other barges, to a seabed power collection system and then, finally, to an inverter-transformer-control hub platform, which could be a fixed or floating offshore platform. The hub platform will be very important because of the value of the power going through it. It will most likely house personnel who can be quickly dispatched to fix problems on the barges and maintain continuous power output. The hub platform will invert the power if needed, transform the power, control the farm and export the power by an efficient, high-voltage power cable to its end-user.

This barge overcomes significant challenges that have faced the marine energy industry for years. The capture, conversion and transmission of significant marine power is as economically efficient as onshore wind. The barge is low cost and low risk, with quick installation and removal. Safe offshore, above-water maintenance and replacement of almost all mechanical components, minimal environmental impact and minimal visual pollution make the barge reliable. Service lasts for 15 years or more, until hull repainting is needed. It has the robustness to survive extreme, more than 100-year return period storms.

Barge Design

Waves apply cyclic prying forces between the barge and the seabed. The waves lift the barge up, and the barge's

The Wave Catcher Barge's clear enclosure allows view of key internal components.



The external view of the Wave Catcher Barge illustrates simple, low-cost barge fabrication.

mooring belts try and pull the barge back down. After going over a series of large-diameter pulleys, the waves apply a large turning force to the flywheel that turns the generators. The larger the barge's bottom area and the higher the waves, the higher the mooring belts' vertical lift. The higher the forces, the more power is produced. All of this results in wave energy being transferred to the barge, then to the mooring belts and finally the generators, which convert the energy to electric power. The energy conversion efficiency should be more than 80 percent.

The articulated pulley, the first pulley the mooring line belt goes over, is housed in a wet room on the barge. The articulated pulley is aligned with the long axis of the barge and normally will not significantly change its angle if the bow of the barge remains headed into the waves. However, if the barge has a fixed heading, the waves will sometimes hit the barge from the side, and the articulated pulley will change angle as the mooring legs incline to the side. The second pulley that the mooring line belt goes over is a unidirectional pulley with a recoil spring, like the pulleys and recoil springs on a lawn mower starter. The unidirectional pulley keeps the mooring leg belt applying torque to the generator in the same direction. The recoil spring in the unidirectional pulley rewinds the mooring leg belt back onto the unidirectional pulley when the barge enters the wave trough. The unidirectional pulley is turned by its mooring belt each time the wave crest lifts the barge, and the unidirectional pulley turns the large flywheel. The flywheel then turns the generator. The flywheel temporarily stores wave energy in the form of momentum and keeps turning when the barge enters the wave trough. All mooring legs' belts do the same thing with their pulleys, flywheels and generators. Many of these separate components may someday be combined into one component, saving weight, space and costs.

Mooring Systems

The Wave Catcher Barge can use many types of moorings systems depending on variables like water depth, environmental conditions, desired efficiency, etc. The mooring legs are long enough to allow the barge to ride the 100-year storm waves. The bow has a long, gradual taper to the horizontal, which causes both horizontal and vertical wave forces to lift the barge as high as possible under normal sea conditions. The bow's shape diverts extremely high storm waves and winds, laterally minimizing horizontal loading.

Meeting Challenges

Barges are the lowest-cost floating offshore structures and can be sized for normal waves to produce enough upward force for the vertical mooring lines to turn four large wind turbine generators. The result is significant power generation from one barge.

A conceptual design has been carried out for a possible barge in normal, 2-meter significant waves. The costs would be similar to onshore wind power when using the costs of known components, like a typical deck barge, high output wind turbine generators, direct seabed mooring systems and typical offshore installation costs.

These barges are able to transform the power on board to DC or AC and export the power via cables that do not touch the seabed.

Any structure placed in the ocean for a long period of time must meet the design requirements of the local government. Most countries have written requirements for offshore structures that refer to the rules of a major class society or the requirements of a major international code, like API or ISO. In most cases, these codes and governmental requirements dictate that the offshore structure be capable of surviving at least a 100-year return period storm.

Thousands of offshore structures have been installed all over the world to explore for or produce oil and gas. These structures are designed to minimize wave loading for 100-year storm conditions. This is done by minimizing the structures' vertical and horizontal wave areas.

Floating offshore structures are often made to be compliant and avoid vertical mooring leg forces by freeing the structure's vertical movement. Rather than avoiding the vertical wave forces, the Wave Catcher Barge uses the vertical wave forces to generate power.

The barge uses conventional existing components like a conventional barge with mooring system, wind turbine type generators; articulated pulleys; unidirectional pulleys with recoil springs; and conventional mooring legs, which transition to steel-reinforced rubber belts to cross the pulleys and

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turn the generators. Various types of conventional mooring systems can be used to allow the barges to be moored in almost any water depth. Some mooring systems impose minimum vertical load on the Wave Catcher Barge, allowing it to generate power at peak efficiency.

Conventional components allow the barge to be engineered, fabricated and installed quickly. The barges can be towed to and from the site with conventional tugs.

With the help of an ROV and quick subsea connections, the barges can be connected and disconnected to preinstalled moorings in less than a day.

Barges offshore are safely maintained, since all mechanical components are above water in a water-tight enclosure with helicopter access.

Using at least four proven high-output, wind turbine-type generators and mooring systems allows the maximum power generation efficiency.

The barge can either have a fixed heading into a normally favorable direction for power generation, or can be free to weathervane and keep its bow headed into the waves at all times. It can be moored to an intermediate preinstalled, subsurface structure for quick shallow water connection. The subsurface structure can optionally support current generators to further increase the power output of each installation.

The barge can have a horizontal bow mooring and keep the vertical mooring legs near vertical under prevailing weather conditions.

It can have a horizontal bow mooring connected to a spring buoy single-point mooring and have the vertical mooring legs connected to a negatively buoyant counterweight/sea anchor, which will allow the barge to always weathervane into the highest weather conditions for maximum power output.

A horizontal mooring to other surrounding wave catcher barges allows each barge in the wave farm to laterally support the other barges under significant storm conditions.

All of the mooring anchors can be preinstalled. This is commonly done today using dynamically positioned crane vessels that are able to hold their position in harsh conditions while working in very deep water. After the anchor piles are installed, an ordinary tug can tow the barge to site and hold its position while an ROV connects its mooring legs to its anchor piles in about one day. The installation process can be reversed to also remove the barge in about one day.

Corrosion-resistant, steel-reinforced rubber belts are used for mooring legs. The mooring legs transition to belts below the hull, and the belts then go over the large diameter pulleys inside the hull enclosure. The belts are like the long-life belts used in automobile engines and provide long service life. Rubber is resistant to seawater splash zone corrosion and prevents the steel wire inside from corroding.

The Oceans: Our Next Power Source

The Wave Catcher Barge is a major step forward in marine power generation, providing further momentum in the use of the oceans as our next power source. Harvesting significant amounts of marine energy is the goal of the Marine Energy Corp., who welcomes all interested parties to join them in this exciting future. Oil and gas platforms, desalination plants, naval bases, chemical plants, island communities, offshore harbors, offshore fish farms, marine labs, coastal cities, offshore mining and offshore drilling can all benefit from this power.

Ongoing Development

The barge has not undergone testing yet; however, conceptual engineering indicates installed costs and power outputs should be similar to onshore wind power in optimum wave environments. Naval architects will carry out vessel sizing for optimum vessel motions and mechanical engineers will design the large pulleys and flywheels this year. Barge fabrication advice will also be obtained this year. One of the largest wind turbine generator suppliers will help with the generator design interfaces. The foundation and mooring system will be based on design assumptions, which could change based on partner input. Prototype model testing is planned for 2015, based on design work carried out this year. ■

Donald Gehring has worked for more than 38 years designing, fabricating and installing offshore projects all over the world. This work includes hundreds of fixed offshore platforms, five TLPs, eight FPSOs, three FPSs, two FSOs and seven very large topside floatovers. He holds eight patents.