A Densely Packed Array of Vertically Oriented Linear Faraday Electrical Generators Used as Point Absorbing Wave Energy Converters to Transform Ocean Surface Wave Kinetic Energy into Electrical Power

Extractable ocean wave energy with its high power density is thought to be the most concentrated, most consistent, and potentially cheapest renewable energy source. Much of its 2 Terawatts (World Energy Council), which is twice that of current world electricity production, is within US water resources.

Prior wave energy harvesting technology used single or several large widely spaced units resulting in most of the propagating wavefront not intersecting a device causing significantly reduced efficiency. Serious problems included low conversion efficiencies, large numbers of moving parts with complicated mechanical power trains, hydraulic fluids with risk of leakage into the environment, huge capital costs, unwanted environmental effects, and reliability issues in harsh marine environments.

This phase I proof of concept project will prove the feasibility of using many small floating wave energy converter (WEC) omnidirectional energy point absorbers as a surface energy attenuating dense carpet-like array to harvest electrical energy over water areas of arbitrary shape and size. Each proposed WEC, comprised of a radically different vibrational vertically oriented Faraday linear electric generator (LEG) with a patented arrangement of compressed repulsive magnetic fields radiating perpendicular to and along its entire vertical axis as well as protective electromagnetic braking, has improved efficiency, a only one moving sliding structure, a low ecological impact, and no hydraulic fluids. The LEG is protected against violent motion from large waves by a repulsive magnetic and electromagnetic braking system. WEC arrays of arbitrary size or shape are attached by either rigid or flexible tethering to bulkheads, seawalls, and docks, anchored to the seabed, or freely floating. The arrays can be shaped into the form of disks, rings, strips of varying numbers of layers of WEC's, or polygons, all of arbitrary geometric dimensions. An array can be as simple as a single WEC thus allowing it to be incorporated into wave driven power supplies that can be used to energize navigational or instrument buoys, or to serve as emergency power sources for boat operators. The buoy shaped WEC's use low cost standard components. The WEC's themselves can be tethered together either in a flexible manner allowing the array to ripple with the waves or in a rigid manner causing the array to behave like a boat structure. The WEC is simple to transport, install, service and replace. Simple power collection circuit (PCC) modules consisting of four different types of multiple phase AC to DC rectifying and filtering circuits allow for the production of unipolar voltage outputs, bipolar voltage outputs, voltage summation outputs, and current summation outputs that allow for huge flexibility in harvesting the many AC current voltage sources emanating from each of the many coils on each of the many WEC's that comprise the array. By using these four different circuits as components to build up increasingly more complicated PCC's serving many WEC's each with many power generating coils, the hierarchical PCC can combine an essentially unlimited number of separate WEC AC to DC power sources from a large assemblage of LEG's into one output from which electric power is harvested from the array and transmitted to shore by electric cables. Alternatively, if the array is located far from shore beyond the range of conventional electric cables, the harvested electrical energy can be converted to stored chemical energy such as lithium battery banks and then used as needed on demand. As ocean waves propagate through the array, their amplitude decreases as their kinetic energy is changed into electrical energy by each successive WEC they encounter. Multiple patents describe the key components of this ocean wave power conversion process. The pre-prototype LEG structure has produced considerable electricity (up to 60 W) while floating in a water environment.

To prove feasibility of this project, five hypotheses must be validated:

1. Each WEC can produce a sustained 100 to 1000 W in the harsh marine environment.
2. Electrical output of the array is maximized using the optimal configuration of the PCC from the individual WEC's.

3. An array and its individual WEC's remain stable structures as waves propagate through it during variable weather conditions.
4. Densely packed small WEC's are superior to widely spaced large units.
5. The technology has few unwanted environmental effects.

Research is ongoing in verifying that these hypotheses will validate this technology as a significant, reliable, and transformative method capable of harvesting large amounts of electricity from ocean wave energy. The WEC array is applicable to any sized body of water capable of sustaining propagating water waves. Optimally scaling up LEG magnet coil structure size, WEC number per array, and array shape, density, and geometric size for a given location to achieve maximal power output, conversion efficiency, and reliability can make grid applications realistic. This ocean wave energy conversion system can transform US energy production by reducing energy costs, carbon emissions, and hydrocarbon imports with new job creation from mass manufacture of the WEC, a potentially truly beneficial and disruptive technology.

Furthermore, with suitable modifications and downscaling of the physical size of the LEG, in addition to the vibrational LEG being used in ocean wave harvesting, there are a host of other applications for harvesting vibrational energy on land. These include harvesting the vibrational energy of hybrid trucks and cars via the use of electromagnetic shock absorbers feeding back the generated electric power to the vehicle's battery bank to extend range per tank of gas, providing energy from the vibrations to trains on rail tracks to power sensors, harvesting wind generated vibrational energy of tall buildings, and converting the vibrational energy of turbulent rivers and small height waterfalls to electric power in scenarios that do not lend themselves well to conventional rotary generator hydropower units.

A still further downsizing of the technology allows for the production of electrical energy from the movements of the human body. The exciting new field of external human electrical energy harvesting of kinetic energy produced by body motion can take the form of wearable size vibrational generators that are embedded in clothing and backpacks or strapped to the body for charging and enhancing the use of mobile electronics.

Because the multiple applications outlined here for the Vibristor-R vibrational LEG that potentially can go beyond just ocean power wave harvesting, mass production of the vibrational LEG and its use in various devices can give rise to a significant amount of transformational industrial manufacturing and job creation in several possible markets. All of the applications of this technology irrespective of size of the power generating LEG structure tap an inexhaustible, cheap, reliable, and consistent source of energy characterized by positive eco-friendly environmental effects such as decreased carbon emissions and hydrocarbon imports. Most importantly, vibrational sources of energy harvested from many potential applications using this innovative environmental kinetic energy to electrical power conversion process make possible an especially beneficial, transformational, and possibly disruptive technology that can impact the landscape of US energy production in the future.