Distributed Embedded Energy Converter Technologies (DEEC-Tec)

Enabling a Paradigm Shift in How Marine Energy Is Harvested and Converted

NREL
Transforming ENERGY

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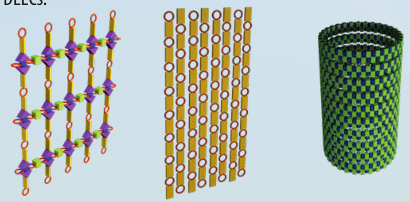
Technology Level One: DEECs

Individual Distributed Embedded Energy Converters (DEECs) are the smallest, most fundamental unit of the DEEC-Tec hierarchy; often having characteristic lengths of less than a few centimeters. An individual DEEC has two foundational roles: (1) being an energy transducer and (2) being a structural mechanism. As an energy transducer, an individual DEEC converts some form of inputted energy into another type of energy, such as electricity or fluidic pressure, via the use of a physical phenomenon that could (for example) range from variable capacitance to piezoelectric. As a structural mechanism, an individual DEEC enables its connection and linkage to other DEECs—thereby facilitating the creation of DEEC-Tec metamaterials. Below are five simple pictorial representations of DEECs. They are an illustrative means to show that individual DEECs can come in different shapes and sizes with, correspondingly, different properties and characteristics.

Pictorial representations of DEECs

Technology Level Two: DEEC-Tec Metamaterials

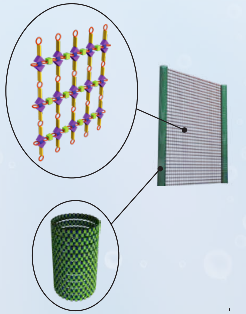
DEEC-Tec metamaterials are the second level of the DEEC-Tec hierarchy and are structural frameworks created from or consisting of various combinations and/or interconnections of one or more types of individual DEECs—the arrangements and compositions of which determine the properties and characteristics of that structural framework. Several metamaterials may be further combined together to form 2nd, 3rd, Nth order DEEC-Tec metamaterials. Likewise, individual DEECs can be combined to form any number of DEEC-Tec metamaterials such as latices, skins, columns, etc. Below are three simple pictorial representations of DEEC-Tec metamaterials constructed from the connection of many individual DEECs.

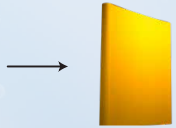


Pictorial representations of DEEC-Tec Metamaterials

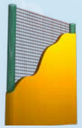
Technology Level Three: DEEC-Tec-Based Marine Energy Converters

DEEC-Tec-based marine energy converters are the third and final level of the DEEC-Tec hierarchy. They are complete structures composed of one or several types of DEEC-Tec metamaterials. As an example, illustrated is a DEEC-Tec-based wave energy converter that is a "bottom-fixed surging flexWEC." This type of wave energy converter bends and twists due to surging ocean wave forces with that bending and twisting causing the converter's distributed embedded energy converters (which makes up the converter's structural volume) to dynamically deform. The dynamical deformations can be dampened per individual distributed embedded energy converter by way of electricity generation—the damping mechanism is the source of electricity generation.

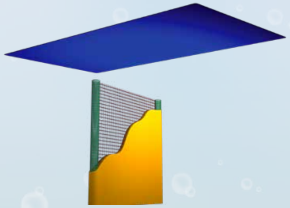




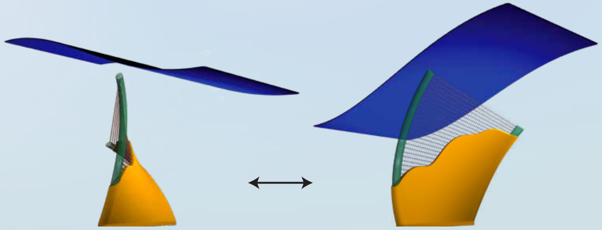
Embedded into a compliant cover or substrate.



Compliant cover/substrate partially removed to illustrate internal DEEC-Tec metamaterials.



Archetype under still water.



Archetype under ocean wave action being dynamically deformed by ocean wave energy.

Pictorial representations of a DEEC-Tec-Based Marine Energy Converter: A Bottom Fixed Surging FlexWEC

Advantageous Features: Broader Spectrum of Energy Capture • Near-Continuous Structural Control • Mechanical Redundancy • Reduced Maintenance • Favorable Materials • Easier Installation • Resilient