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On the road to innovations

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NREL Transforming ENERGY

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INTRODUCTION

This poster provides an overview of the methods and innovations arising from the Wave-SPARC project – how it started, what has been considered, and where is it leading. Initially, the project was called “Structured Innovation” and focused on defining the Technology Performance Level (TPL) a detailed “Systems Engineering” analysis that delivered all stakeholder requirements across the system lifecycle, expressed in capabilities and functions of the wave farm to service the competitive continental grid market. TRIZ Techniques, or the theory of inventive problem solving, were pioneered in the Soviet Union as the study of patterns of invention, beginning in 1946. Application of TRIZ techniques to marine energy led to several “new” WEC ideas two of which are presented on this poster.

AIM

The aim is to identify and evaluate innovations necessary to yield high techno-economic wave energy farm solutions. Capabilities required are listed under these main headings:

C1: Have market competitive cost of energy.
C2: Provide a secure investment opportunity.
C3: Be reliable for grid operations.
C4: Benefit society.
C5: Be acceptable to permitting & certification.
C6: Be safe.
C7: Be deployable globally.

Applied to any WEC, the TPL assessment identifies areas with high and low performance.

METHOD

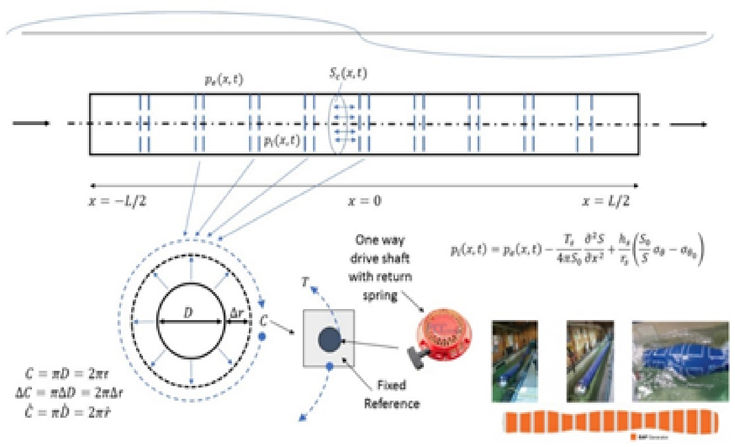
For the engineering challenges associated with wave farm developments, 62 Functional Requirements were formulated under five main categories:

F1: Generate & Deliver Electricity from Wave Power
F2: Control Farm and Subsystems
F3: Maintain Structural and operational integrity of farm and subsystems
F4 Provide suitable access and transportation
F5: Provide Synergistic Benefit

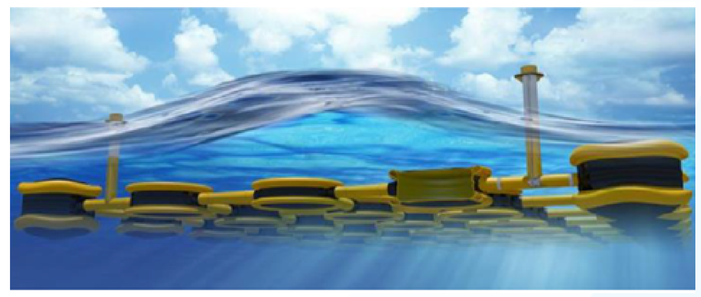
TPL assessment tool (tpl.nrel.gov), combines the functional requirements and associated WEC farm capabilities into a an overall score.

RESULTS

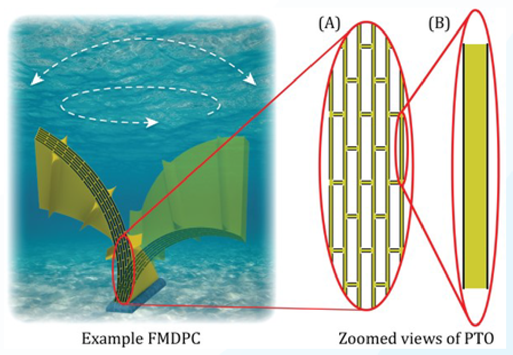
Initially the TRIZ methodology was used abstractly by reviewing the functional requirements of WECs and for specific subcomponent WEC functions – thereby identifying key contradictions and corresponding solutions (or partial solutions) to address the contradiction. The team discovered that in some cases application of TRIZ could lead to the re-invention of already known WEC systems (and/or subsystems) such as: surging flaps, point absorbers using negative springs, and flexible WEC structures. Hereby, TRIZ led to solutions through crossing WEC technology archetype boundaries which proved its capability to dissolve contradictions and go well beyond parametric optimization.



Power conversion subsystem replacement though the use of conventional engineering design principles, components and supply chain.

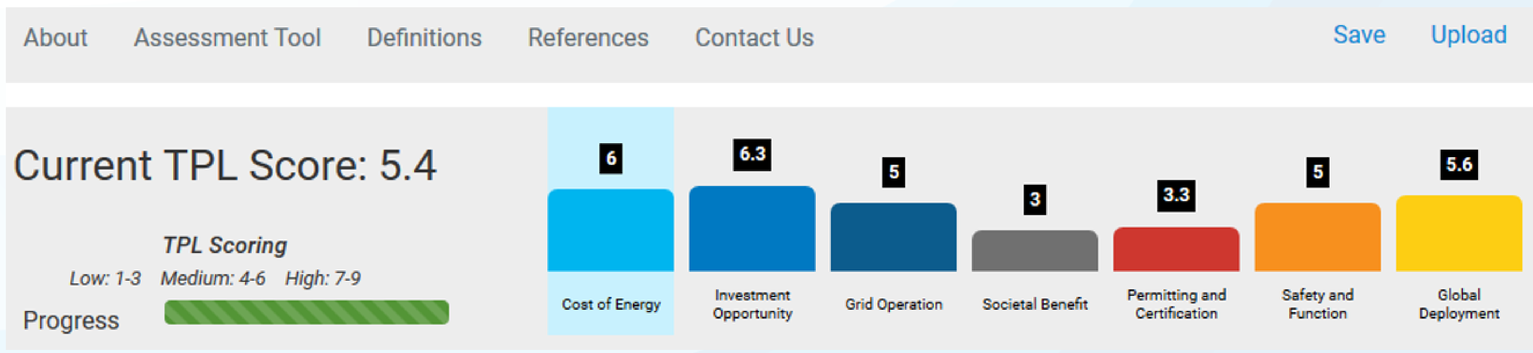


Communicating volume clusters, interconnected through PTOs with integrated resonance adjustment



Bottom mounted flexible multi-modal and multi-dimensional deformer with embedded PTO.

The TPL assessment tool has also significantly enhanced and provided as an online tool (tpl.nrel.gov), combining functional requirements and associated WEC farm capabilities to identify and evaluate innovations necessary to yield high techno-economic wave energy farm solutions. .



CONCLUSIONS

Wave-SPARC has marched forward in its use of the “TRIZ inventive problem-solving technique.” and 12 unique innovations so-far have been discovered ranging from clusters of submerged absorbers, to floating structures, different innovative types of PTO systems, innovative moorings connectors and use of novel materials and design techniques. Each innovation is going through an analytical verification process and upon completion the most promising innovative WEC concepts will be further progressed in cooperation with industry.

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