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Multicriteria analysis to evaluate wave energy converters based on their environmental impact: an Italian case study

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The exploitation of renewable energy resources is fast becoming a key objective in many countries.
Countries with coastlines have particularly valuable renewable energy resources in the form of tides, currents, waves and offshore wind. Due to the visual impact of siting large numbers of energy generating devices (eg. wind turbines) in terrestrial landscapes, considerable attention is now being directed towards coastal waters. Due to their environmental sensitivity, the selection of the most adequate location for these systems is a critical factor. Multi-criteria analysis allows to consider a wide variety of key characteristics (e.g. water depth, distance to shore, distance to the electric grid in land, geology, environmental impact) that may be converted into a numerical index of suitability for different WEC devices to different locations. So identifying the best alternative between an offshore or a onshore device may be specifically treated as a multicriteria problem. Special enphasisi should be given in the multicriteria analysis to the environmental impact issues.
The wave energy prospective in the Italian seas is relatively low if compared to the other European countries faced to the ocean. Based on the wave climate, the Alghero site, (NW Sardinia, Italy) is one of the most interesting sites for the wave energy perspective (about 10 kW/m). Alghero site is characterized by a high level of marine biodiversity. In 2002 the area northern to Alghero harbour (Capo Caccia–Isola Piana) was established a Marine Protected Area (MPA).
It could be discussed for this site how to choose between the onshore/offshore WEC alternative.
An offshore device like Wave Dragon (http://www.wavedragon.net/) installed at -65m depth (width=300m and length=170 m) may approximately produce about 3.6 GWh/y with a total cost of about 9,000,000 €. On the other hand, an onshore device like SSG (http://waveenergy.no/), employed as crown wall for a vertical breakwater to enlarge the present harbour protection, and installed at -10m depth (length=300 m) may produce about 2.7 GWh/y with a total costs of about 12,000,000 €, where only the 50% of the amount are the costs of the SSG device. Obviously the environmental impact of the two solutions is quite different.
Aim of this study is to provide a multicriteria decision support framework to evaluate the best WEC typology and location in the perspective of the environmental cost-benefit analysis.
The general environmental aspects generated by wave power projects will be described. Colonisation patterns and biofouling will be discussed with particular reference to changes of the seabed and alterations due to new substrates. In addition, impacts for fish, fishery and marine mammals will be also considered. We suggest that wave power projects should be evaluated also on the basis of their environmental impacts in the perspective of the Strategic Environmental Assessment (SEA) analysis, as implemented by the European Commission (SEA Directive 2001/42/EC). The early incorporation of the environmental aspects involved in the evaluation of wave power projects will give the opportunity for early mitigations or design modifications, most likely making wave projects more acceptable in the long run and more suitable for the marine environment.