



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

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Project Title Renewable Energy from Ocean Waves Using Piezoelectric Crystals	
Objectives/Goals Can ocean waves bend piezoelectric crystals enough to produce energy? I predict that the greatest amount of energy extracted from ocean waves using piezoelectric methods will be found in waves generated during a high tide.	
Abstract Methods/Materials 1 Assemble voltage measuring board containing 5 40mm X 10mm X .5mm STEMINC Steiner and Martins Inc. Piezo electric Parallel Bimorph Actuators; construction details are in report. 2 Travel to San Clemente Pier with nylon string and weight. 3 Travel to south end of pier after the first light post past the guard tower. 3 Tie string to scale on board. 4 Tie string to weight. 5 Turn all mulimeters to 2000mv. 6 Cast weight into the water. 7 Film readings on meters for 1 minute. 8 Repeat processes 5 more times at high and low tide respectively. 9 Return home and record time, tide, and height of tide. 10 Play film on computer and pause the video every second. 11 Record readings on pre-made chart. 12 Graph data. 13 Draw conclusions.	
Results The voltage readings this investigator obtained proved that low tide produced larger voltage readings than high tide on all three days of data gathering. For the average high and low tide readings on January 1, 2013, the low tide values ranged between 2.4 mV to an excess of 700 mV (absolute values), while the high tide readings were lower at 0.04 mV to 95mV (absolute values). On January 7, 2013, the low tide readings ranged between 0 mV and 400 mV (absolute value), and the high tide readings were lower at 0 mV to 199 mV (absolute value). Finally, for the average high and low tide readings on January 9, 2013, the low tide readings ranged between 1.2 mV and 500 mV (absolute value), while the high tide readings were lower at 0 mV to 206 mV (absolute value).	
Conclusions/Discussion This investigation demonstrated that low tides produced the greatest voltage readings compared to high tides. These results are the opposite of what the hypothesis predicted. However, articles about the motion of waves from Michal Kerrigan, in Coastline, and Darlene Stille, in Waves, are consistent with the data analysis. According to Kerrigan and Stille the energy of the waves is constant, but in shallower water the same energy results in a higher taller wave that displaced the T Bar more and thus acted to bend the piezoelectric actuators more generating greater voltage readings.	
Summary Statement It was demonstrated that ocean waves can deform piezoelectric crystals to produce a voltage and that waves during low tide produce greater voltages than waves during high tide.	
Help Received Thank you to Mom for buying my supplies and taking me to the pier even at night. Thank you to Dad for helping me design and construct the measuring board. Thank you to my brother for taking the video of the trials. Thank you to Mrs. Rivero for trusting outside-the-box thinking and Ms. Jenkin for being patient	