The thesis explores ocean wave dynamics and their impact on the performance evaluation of Wave Energy Converters (WECs). The analysis focuses on Pantelleria, a strategic area for renewable energy, evaluating seasonal and interannual variations in sea conditions and their influence on energy convertion.

The research uses a combination of in-situ and remote sensing techniques to collect wave data, integrating advanced numerical models to more accurately predict the performance of WECs. In particular, the performance of the Pendulum Wave Energy Converter (PeWEC) is analyzed, studying the correlations between wave data and energy conversion estimates.

The results show that the correct interpretation of wave characteristics, including directionality as well as frequency, is crucial for improving the effectiveness of WECs. The thesis highlights the importance of considering multidirectional spectra for accurate evaluation, highlighting how monodirectional assumptions overestimate performance results.

The conclusions suggest that different sources of wave data can lead to significant differences in annual estimates of converted energy, and a correction method to reduce the error induced by the monodirectional assumption is provided.

This study provides a significant contribution to understanding ocean wave dynamics and improving analytical methodologies for estimating WEC performance.