

ASSESSING WAVE POWER FOR SUSTAINABLE DEVELOPMENT IN COSTA RICA:  
POTENTIAL ROLE WITHIN ENERGY MIX AND COMPARATIVE ANALYSIS OF  
NATIONAL ENERGY SOURCES THROUGH TRIPLE I INDEX

René Castro Cordero, GPSS-GLI, 47-136830

Advisor: Professor Toru Sato

Co-Advisor: Professor Ken Takagi

ABSTRACT

Demand for energy and associated services, to meet social and economic development and improve human welfare and health is increasing. All societies require energy services to meet basic human needs (e.g., lighting, cooking, space comfort, mobility and communication) and to serve productive processes. Since approximately 1850, global use of fossil fuels (coal, oil and gas) has increased to dominate energy supply, leading to a rapid growth in carbon dioxide (CO<sub>2</sub>) emissions. (IPCC, 2012).

Furthermore, to achieve true sustainable development energy should be acquired from renewable, low carbon, constant resources that provide stability to the grid and increase resilience to climate change, as stated by The United Nations General Assembly when calling upon member states to “galvanize efforts to make universal access to sustainable modern energy services a priority”. Stressing particularly on the importance of improving access to “reliable, affordable, economically viable, socially acceptable and environmentally sound energy services and resources for sustainable development” (United Nations, 2014), thus promoting reduction of poverty, improved health conditions and mobilizing societies towards development. Costa Rica, a small Central American nation has consequently proposed attainment of Sustainable Energy for All (SE4ALL) as well as unilaterally established a Carbon Neutrality goal for the year 2021. For the

nation to reach these goals becomes of great global significance as it would provide a beacon to the world that proves it is possible, while reducing learning curves for other developing nations.

Costa Rica has successfully achieved 98.95% generation of electricity from renewables for the year 2015 and access to 99.28% of the population (IDB, 2016 and Isola Wiesner, 2015). These astonishing results have not been easily attainable for the nation, and ensuring 100% access with 100% renewable sources becomes more and more difficult with a growing population, growing demand and a strong dependence on hydroelectric systems for energy generation in times of extreme climatologic variations.

This study evaluated the possibilities of diversifying the energy mix with carbon neutral energy systems to attain said goals. Additionally, it evaluated the possibility of introducing ocean energy produced by waves, as a means to achieve this. Ocean Energy has been proposed as one of the potential solutions to be considered both globally and locally; however, significant research on the topic determining its technical, economic, environmental and social viability must be developed. Most research and development relating to ocean energies has been conducted in developed countries of the northern hemisphere. Biological and climatological conditions, as well as social and economic characteristics outside of the tropical belt are significantly different than those of the territories inside; adaptation of ocean energy technology studies to the developing and tropical context is of utmost importance.

The study pays special attention to public acceptance considered one of the most relevant issues and barriers for evaluating the sustainability of anthropogenic systems. “The development of energy systems in the future will depend on the balance of environmental impact, economic feasibility, and public acceptance.” (Takahashi & Sato, 2015) In addition, the study determines the effects of public preference in terms of acceptance or aversions to specific impacts as to define the

Marginal Willingness to Pay of population, and evaluate the impact on project viability it could have.

Results identified economic barriers in the pricing of electricity that limit diversification of the energy mix. Additionally, the prohibitive nature of costs of ocean energy systems is further confirmed, and market conditions are determined for viability of wave energy to be achieved. Potential gaps in policy are defined for the regulation of ocean energy.

The study elucidates public preference of energy sources and potential market niches. Further studies to adequately price electricity without significantly affecting the industrial sector are recommended. Finally, potentially viable energy sources, such as wind and biomass, for an improved energy mix, attainment of Carbon Neutrality, and SE4ALL are determined.

*Key words:*

Renewable Energies, Ocean Energy, Triple I Index, Public Acceptance, Sustainability Indexes