Energy policies, education and sustainable development goals applied to low developed countries - a symbiotic case study

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***Abstract*— Energy, its use and management, weighs heavily on the burden that each society can impose on a fragile balance of nature, with implications not only environmental and financial, but also social, creating jobs and improving quality of life. Devising strategies that combine these three factors are a valuable option that will yield good results, meeting the challenge of fulfilling the Sustainable Development Goals (SDGs). The most important thing is to implement the old maxim: "no one is left behind", so low developed countries are an opportunity to achieve impressive results, while allowing them to improve their way of life and their comfort. It's often said that 'action begets reaction', so any positive action taken in the community can have social repercussions, such as improving the quality of education and knowledge about sustainability. This study will provide an overview of how energy management and environmental mitigation strategies can impact underdeveloped countries.**

Keywords— Sustainability, Strategies, low development countries.

I. INTRODUCTION

It is a fact that education and the power to raise awareness and disseminate knowledge among society share intrinsic links. Likewise, the experiences we take in society direct individuals toward what attracts and motivates them. Although there are several strategies to solve the energy problems/crises of the future, education presents itself as the main one[1]. Currently, energy remains a topic of high interest in science education. The main reason remains the constant problems and challenges in the management of energy resources, which in turn creates a need for helping students become better positioned to solve society's problems [2].

Sustainable development lacks a precise definition [3], yet United Nations (UN) initiatives have unified discussions around it, notably through the establishment of the SDGs in 2015 [4]. These goals serve as a global framework for collaborative efforts towards sustainability across various sectors, including higher education institutions (HEIs). The SDGs represent an interconnected set of objectives, contrasting with criticisms of the earlier Millennium Development Goals. They encompass both synergies, where progress in one goal aids others, and trade-offs, where advancements in one area may hinder progress elsewhere. Despite their interconnections, the Agenda 2030 goals are unequally connected to each other, with some goals connected through several targets while others are loosely associated with the others, if at all [5].

Addressing these challenges necessitates educational reform, particularly within HEIs. Students, often lacking in-depth knowledge of sustainability upon entering HEIs, represent a critical demographic for promoting sustainability. However, the integration of sustainability into HEI programs remains inconsistent, varying from institution to institution. While some universities prioritise sustainability through curriculum requirements, others offer limited exposure to the SDGs. Additionally, disparities exist in on-campus sustainability initiatives, limiting student engagement beyond academic endeavours [6].

The need for the involvement of various agents of academic communication, from students, teachers, as well as staff, becomes evident, not only because they are active agents involved in knowledge and teaching, but because of the power they have to influence society, disseminate information and persuation to get the community involvemed in projects developed with their own objectives focused on improving quality of life, associated with sustainability issues. Such projects present themselves as excellent opportunities to implement the old maxim: everyone counts, regardless of economic power or social position. Currently, scientific projects have been developed in order to stimulate the academic community and its agents, with the Engineering Education for a Sustainable Future Project being an excellent example.

II. IMPACT REGARDING THE SUSTAINABLE DEVELOPMENT GOALS

This work brings an original analysis contribution, which makes an allusion to the Sustainable Development Goals (SDGs), which are considered to have a positive effect on the following SDGs:

- SDG 1 – No poverty: Creating jobs and stimulating employment creates financial

returns, resulting in greater chances of stability and quality of life;

- SDG 2 – Zero Hunger: Employment creates financial return, and these opportunities are crucial in low-development countries, which sometimes determine whether a household has the minimum conditions for survival, reducing the risk of exposure to hunger. ;
- SDG 3 – Good health and well-being: The introduction of technologies that help to improve environmental, financial and social aspects improves living conditions and quality of life, thus contributing to well-being.;
- SDG 4 –Quality Education: Projects such as the case study that increase the knowledge of society and the benefits that come from these improvements, direct new generations to obtain knowledge to replicate attitudes and strategies, as well as interests that can improve the quality of life of the population;
- SDG 7 – Affordable and clean Energy: The use of LED lamps allows considerable savings on the annual energy bill, so the case study plays a fundamental role as it involves actions in a low-developed country;
- SDG 8 – Decent work and economic growth: The creation of jobs and employment allows the improvement of the population's living conditions, the contribution to the social fabric and cohesion, as well as to the country's financial contributory system, resulting in economic growth;
- SDG 9 – industry, innovation and infraestructure: The present case study stimulated the industry, creating new jobs and consuming resources, using local labor, and using innovative technological products, creating differentiating solutions;
- SDG 11 – Sustainable cities and communities: The present case study used aggregating concepts intrinsically linked to sustainability, such as circular economy, reuse and recycling of construction materials;
- SDG 12 – Responsible consumption and production: The use of LED technologies for lighting solutions is a great example of responsible consumption, thus allowing the population's overall energy consumption to be reduced, thus relieving the country's energy matrix;
- SDG 13 – Climate action: The use of LED technologies means lower energy consumption, thus translating into lower carbon emissions associated with energy sources. The reuse and recycling of materials results in alleviating the environmental impact that this case study has on the environment.
- SDG 17 – Partnership for the goals: The present case study involves several entities, from financing entities to entities that develop projects that incorporate and create sustainability concepts in their solutions, such as employers that stimulate employment and opportunities to improve the lives of the local population. All of these partnerships had a considerable impact on the case study country, thus achieving the outlined objectives.

III. A CASE STUDY

This case study took place in São Tomé and Príncipe. This small, two-island, lower-middle-income nation of around 960 square kilometres has significant untapped natural wealth. In terms of education, São Tomé and Príncipe has a young and increasingly educated population. Around half of the total population (225,000 individuals) is under 18, with a secondary school enrolment rate of 89%, the life expectance at birth is 70.4 years and And it is in place 191 out of 203 country at Carbon footprint per capita ranking (from high to low) [7]. Despite a GDP per capita of around 2,817 dollars, the country is socially and economically vulnerable due to high poverty rates, income disparity and low employment[8]. Recently there has been a drop in economic activity, due to the persistent energy crisis, a serious fuel shortage that has had the capacity to slow down, and delays in disbursements of external financing. Because the country faces so many challenges in various aspects, it becomes imperative to create actions with the population that benefit their well-being and living conditions, as for example, the implementation of funded projects.

The present case-study project called ‘Recovery of the Electricity Sector’, approved and co-financed by the World Bank and the European Development Bank, the Project Administration Trust Agency (AFAP) and the Water and Electricity Company (EMAE), aims to help São Tomé and Príncipe achieve more reliable and sustainable levels of energy production, transmission, distribution, consumption and commercialisation. Within this project is a component called ‘Management generated by residential customer demand’, a transition programme to more energy-efficient light bulbs, replacing less efficient ones as shown in figure 1.

Fig. 1: Low-efficiency lamps from hoouseholds collected within the scope of the project.

This component includes actions such as:

- Purchase of 300,000 LED light bulbs and 93,000 tube-type LED bulbs;
- Acquisition of two shredders for incandescent lamps (ILs), fluorescent lamps (FLs) and compact fluorescent lamps (CFLs);
- Communication, publicity and awareness-raising campaign;
- Measuring and evaluating the impacts of the 'LED Programme';
- Distribution of LED lamps to customers in EMAE's domestic and institutional segments;
- Destruction of collected ILs, FTLs and CFLs.

The waste from the replacement must be collected, stored and treated in accordance with best environmental practices as shown in figure 2, with particular emphasis on the hazardous substances that this equipment contains, such as mercury vapour and metallic gases.

Fig. 2: Storage and preparation for forwarding to appropriate treatment.

Tubular or compact fluorescent lamps, as shown in figure 3, contain mercury ranging from 0.004g to 0.045g, which makes them potentially dangerous for the environment) for LED technology in public buildings, but also in private dwellings.

Fig. 3: Example of a lamp collected from a house.

Allowing the use of a more environmentally sustainable technology, the main aim of this operation is to reduce energy consumption, which is substantially lower with LED technology. Mercury is naturally present in the environment, but is generally safely contained in minerals and does not present a significant risk. The problem arises due to human activities, which result in the release of large quantities of mercury into the environment, which can then continue to circulate freely for thousands of years. Mercury in water and sediment is the main concern, as it is in a highly toxic form and can be easily absorbed by animals, thus entering the human food chain.

The main source of human exposure to mercury is through shellfish. When marine animals ingest mercury, it tends to remain in their organisms and accumulates over time. Large predatory fish generally have higher concentrations of mercury because they feed on smaller animals that have already ingested mercury. Therefore, the consumption of large predatory fish, such as tuna or swordfish, will usually result in a higher intake of mercury compared to the consumption of smaller fish that are lower down the food chain.

The health effects are related to the amount ingested, but the main concern is the effect of mercury on the foetus and young children. Exposure to mercury can affect the uterus. This can have serious and lasting consequences on the development of the baby's brain and nervous system, and can affect memory, language, attention and other abilities. As São Tomé and Príncipe is an island country where the diet is based on fish consumption, the importance of avoiding such contamination is paramount. According to the initial estimates for the light bulbs to be replaced, this project will target 100% of the population and part of public buildings, namely schools and health centres. In order to reuse / recycle the waste generated by the destruction of these bulbs, the products resulting from the recycling of incandescent bulbs were transformed into glass sand as shown in figure 4.

Fig. 4: glass sand resulting from the destruction of bulbs.

Subsequently, this material is used as a component to make garden benches as shown in figure 5.

Fig. 5: Manufacturing process for concrete benches with glass sand.

An information plaque was attached to these benches alluding to the project, as shown in figure 6 thus raising awareness among the population of the importance of the circular economy, recycling and the impact that these actions can have on the environment and on serving the population.

Fig. 6: Example of a manufactured concrete bench.

The importance of these projects has an impact on the social fabric and employment, thus creating jobs as shown in figure 7, creating gross wealth and stimulating the country's growth.

Fig. 7: Employees responsible for crushing lamps and producing glass sand.

IV. Results

This case study had a very positive impact in this underdeveloped country on different aspects, including environmental, economic and, above all, social. From an environmental point of view, the switch to LED bulbs enabled the benefiting families to obtain better quality artificial lighting, achieving greater energy efficiency in their homes and considerably reducing the carbon footprint associated with energy consumption. Recycling the bulbs and reusing them in the manufacture of concrete benches avoided difficult-to-treat waste, and is an excellent example of circular economy and the useful life of building materials. From a financial point of view, LED lamps enable households to make huge savings on their energy bills. As if that weren't enough, the investment in buying the lamps for this project was borne by the funding organisations, so the households didn't have to bear the cost. On the social side, job opportunities have been created, resulting in opportunities for the community to achieve a higher quality of life and stability. The scope of the project and its impact has also made it possible to sensitise the community to aspects related to sustainability.

V. Conclusions

The development and implementation of creative projects with sustainable and innovative solutions in society are highly efficient in enticing, captivating and promoting skills and qualities in the population and new generations, as it motivates them to continually improve solutions and knowledge. In the case study, such as the case of a low-development country, job opportunities that provide financial returns are crucial for household stability. In the environmental aspect, the introduction of technological elements made it possible to improve the energy efficiency of households, thus contributing to the financial aspect, reducing the costs related to the energy bill. All these aspects strongly influence the improvement in the quality of life, which is the main purpose of technological development.

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