CHAPTER

8

Sustainability based on water, energy and food nexus

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Sarita Felizardo Assis Pacheco
ORCID: https://orcid.org/0009-0000-2570-1485
E-mail: drasaritapacheco@gmail.com

ABSTRACT
The current paper, based on scientific articles developed in Spain, India and England, studying the transition in food - energy - water - climate, it was reported that there was an increase in methane gas emissions related to the construction of dams. The impacts of solar water pumps, which showed positive results in the economy of the Indian State, contributed to its economic growth, raising it to the 2nd place in the world ranking. The study also covers sustainable approaches applied at a university in England with the aim of reducing costs and creating a test bed for a new environmental footprint, thus giving a perspective for the analysis of nexus. The method used to develop this article is directly interconnected with AMREC's timeline. Given the proposal, we can understand the immediate need to apply sustainability to not only dilute economic spending, but bring a new perspective to the modern world.

Keywords: Sustainability, Emission of methane gas, Solar pumps, Waste treatment.

1 INTRODUCTION

Currently, the search for quality of life requires individuals to not only be an observer, but also an active agent in society in the search for the preservation and conservation of natural resources, human rights and social equality.

Discussions about sustainability have been on the agenda since the 1970s, when society started to worry about environmental issues. At the Conference of the United Nations (UN), held in Stockholm in 1972, a new type of development called Ecodevelopment was proposed. In 1987, through the document Our Common Future, known as the Brundtland Report, a new concept of development was presented which "meets the needs of the present without compromising the ability of future generations to meet their own needs". Rio 92, organized by the UN, was another remarkable event as documents such as Agenda 21 were created (Sachs, 2012; Stafford-Smith et al., 2017)

In 2002, the Millennium Development Goals (WHO) were established and in 2015 the 2030 Agenda was created which includes 17 Sustainable Development Goals (SDGs) that establish 169 goals so that all countries may follow a path of sustainable development, with a shared focus on economic, environmental and social inclusion goals (Sachs, 2012; Stafford-Smith et al., 2017).

In this context, comes the discussion of the theme "Water-Energy-Food Nexus" (WEF: water-energy-food nexus), a concept launched at the international conference "The Water Energy and Food Security Nexus—Solutions for the Green Economy", organized by the German government (Endo et al. 2017) Bring a definition of the nexus/Read and complement: Endo, A., Tsurita, I., Burnett, K.,

& Orenci, P.M. (2017). A review of the current state of research on the water, energy, and food nexus. Journal of Hydrology: Regional Studies, 11, 20-30.

Studies which bring this perspective of integration between water, energy and food resources are still at an early stage, since it is something new and there is much to be observed, especially with an approach to the three elements and a little more about the transition of food, energy and water in a broad scope. Thus, one will also be able to follow the actions of some governments in the face of this triad. In the study by Endo et al (2017), it was noticed through the analyzed works that there was an interaction of water, energy and food resources in only 30% of the articles. The results of the study by Albrescht et al (2018) indicate that only 19% of the articles analyzed focused on the 3 WEF sectors.

Therefore, this article seeks to understand the water-energy-food nexus in a broad aspect, and follow the performance of some rulers in the face of this triad. To this end, 3 articles will be analyzed in which decisions that Spain, India and England have taken based on studies on the advantages and disadvantages regarding productivity in the sectors of irrigation, sustainability and the nexus between them are presented. Through studies carried out in Spain by Eduardo Aguilera et al (2019) we sought to understand irrigation and the increase in water and energy use, as well as the results generated in the construction of numerous dams due to low water levels in their reservoirs. On the other hand, in India, studies by Eshita Gupta (2019) listed policies introduced by the Indian government which are resulting in solid growth in national GDP, due to subsidies for the deployment of solar pumps. In view of this innovative footprint, with studies carried out by Yifan Gu et al (2019) in England, Keele University, through innovative projects, seeks to sustainably reuse and treat waste, considering that its campus has a significant number of students. Based on the points listed above, we will have access to the studies and methods to assess the nexus between water, energy and food.

In the theoretical field, the contribution of this study will be the review of the WEF nexus concept aiming to bring them to academic discussions in the regional-national context. With this, it is believed that it will be possible to subsidize decisions related to public policies involving water resources, energy and regional food. Regarding the social aspect, the integration of State and Society can provide a better quality of life and integration between the parties.

2 THEORETICAL FRAMEWORK

Nexus approach is something innovative in a society that needs to reinvent itself in a sustainable way, that seeks to correlate act and facts to obtain results. The rationalization of nexus extends in a systematic that fully covers the foundations for a sustainable global world.

Sustainability supports not only what guides recycling, but the link between some elements that are preponderantly necessary in the current conjuncture. In view of the analysis by Pedro Roberto

Jacobi et al (2017), among water-food-energy elements there is limited rationalization of the nexus in order to create mechanisms that support each other and result in a positively sustainable balance. The nexus comes to equate the need for a broad view, because, as presented in this study, a certain geographic space, whose relief is favorable, can present greater gain of water resources. However this alone is not a guarantee that it will be inexhaustible. In this way, studies on the nexus are effective in sustainability as a whole, since these techniques tend to connect people and societies as a whole in the search to address deficiencies that some regions suffer.

Currently, many concerns and studies are raised to establish effective goals to contain the lack of control generated by the emission of greenhouse gases as globally it affects all local nature, resulting in a marked imbalance in the ecosystem.

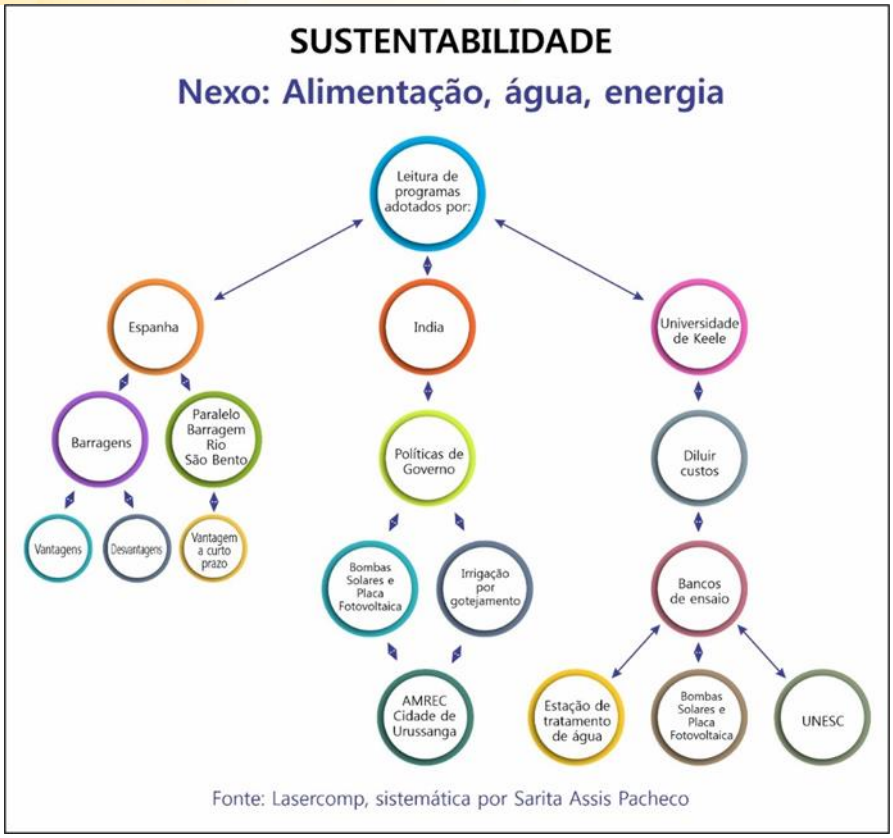
3 METHODOLOGY

The main objective of this scientific article was the reading of five texts from published scientific researches. In these studies, three mechanisms of applicability within different spheres are presented. Surveys in Spain were correlated with the current system seen in our AMREC region. Specifically, I was able to include broader material due to negotiations via email with those responsible for the dam located in the city of Siderópolis.

As for the study that refers to methods applied by the Indian government, I was able to understand the difference between the system adopted in Spain and the method adopted in India. Through this comparison, I understood that with regard to the Indians, disadvantages were not identified, but advantages in short and long term. Another relevant point to mention is that in the same region of AMREC there is already a search for a system of implantation of solar pumps, photovoltaic panels and drip irrigation. However, with the government acting as a Minimum State, leaving all costs to farmers, such implementation becomes expensive and restricted, as not all of them have their own funds or access to loans. This comparison with Indian and the first farmer to install such methods on his land in Urussanga took place through telephone.

In the third phase, we analized search data from Keele University, England. This way, we could understand that sustainability is also relevant in this sector. Keele University proved that all the methods applied and explained above are predominantly effective in this segment, which made us research through reading material if there would be any educational institutions in our region that was using some of the methods used by the English university. However, I was able to find out that in our region there are no sustainability methods in application or in the process of being implemented.

In view of the methods described, the chronological order and the preparation of this piece of research followed the organizational chart below:



Other auxiliary texts allowed us to expand this study and correlate European and Asian experiences with the current situation in the southern region of Santa Catarina. However, the next step will be through field research and opinions on the actions of the Brazilian State towards this issue of sustainability.

4 ANALYSIS OF THE WEF NEXUS STUDIES

4.1 SPAIN – THE PERSPECTIVE OF THE INSERTION OF CARBON DIOXIDE IN IRRIGATION

Spain is a country belonging to the Iberian Peninsula and has a geographical relief in its favor, providing a better use in terms of the construction of dams. Whereas dams are sources of energy and an important source in Spanish irrigation, as described in the Convention on Cooperation for the Protection and Sustainable Use of Waters of Luso-Spanish Hydrographic Basins, as specifically described in Resolution of the Assembly of the Republic No. 66/99, of the 17th of August. During these studies, the analysis proved that dams are effective for agricultural development in addition to the storage of water in this country, resulting in a rapid production of food.

It is relevant to emphasize that such constructions were carried out with the aim of covering several economic sectors. However, their maintenance may trigger harmful effects at a global level. A crucially important fact, which prompts the review of dam effectiveness, occurs when the low level of water in the dams triggers the emission of greenhouse gases. Thus, generating an aggression to the

ecosystem. In view of the listed premises, this study highlighted that sustainable paths must still be sought.

Also, it is crucial to correlate methods applied in Spain, so that they may not be replicated erroneously in other countries and regions. It has been notice that, both in Spain and in the AMREC region, the construction of a dam is always located at a strategic point for serving agriculture, which needs water for irrigation as an inexhaustible source for production. Making a comparison between the dams built in Spain and the São Bento River dam, in the Aguaí reserve, in the city of Siderópolis, Santa Catarina, both were built strategically. As an example, the La Serena dam is responsible for a pasture with abundant cattle and sheep, and this region is remembered for its strong cheese trade. However, when we refer to the São Bento River dam, whose source is the Reserva do Aguaí, in Sideróplolis, its water supports the rice plantation of companies located in the municipality of Forquilhinha, such as Arroz Rampinelli that, currently, received from the public entity the Environmental Friendly Company seal.

Assuming that irrigation generates positive benefits in terms of harvesting, all the necessary requirements for a healthy diet and a bountiful harvest are covered. Nevertheless, when talking about the disadvantages, one can cite numerous negative consequences that over the years have been transforming the global environment. In order for irrigation to reach its objective, it ends up using excessive water and, consequently, energy to pump it to its final destination, thus becoming a cycle of destruction. Thus, an increase in GHG (Greenhouse Effect Gas) is observed.

Understanding the chart:

Fonte: http://www.dsr.inpe.br/projetofurnas/panorama_cont.html

Fonte: https://br.freepik.com/vetores-premium/estilo-de-desenho-de-ilustracao-de-conceito-de-sistema-de-irrigacao_4983256.htm

An abundant plantation is the result of full irrigation, coming from the energy generated by the dams. Excessive use of water reduces its level inside the dams, thus releasing methane gas, which comes from the decomposition of no longer living organisms, such as algae, leaves, roots, among others. The methane gas released is one of the chemical elements directly responsible for the increase in the of greenhouse gases. This gas does not dissolve in contact with water, therefore, it remains at rest on the sides/margins of the dams and also at the bottom of them. When the level of dams drops or they dry up, methane gas is released and, in contact with air, can become flammable.

Therefore, the construction of dams in an accelerated way causes several impacts, but there are three that are the most aggressive for the environment, which are: flooding of productive lands, extinguishing the entire local ecosystem; social changes, with population relocation; and increased greenhouse gas emissions.

The current legal framework that guides sovereign States seeks to integrate with each other for the very common. Spain and Portugal are examples of an alliance for sustainability, as provided for in the Lusa-Spain Water Convention of November 30, 1998.

International law has 3 fundamental functions: the first is for the intervening subjects, it regulates conduct between States. The second is the subject criterion, which deals with the standardization of subject matter to achieve common goals. And the third is the criterion of normative sources, which comes from customary law, which makes norms jus congens. (Mazuoli, 2018)

There is a high rate of irrigated areas in Spain and Portugal as a result of this Convention, which consists of creating a sustainable effect, but on the other hand, over the years, it has created a negative effect with alarming rates regarding the increase in the production of greenhouse gases and considerable changes in the global climate.

4.2 INDIA – THE IMPACT OF SOLAR PUMP INSTALLATIONS

Notably, we have followed the Indian growth since the beginning when navigators sought to anchor in India because of its spices. Its growth took place in the surroundings of the Hindu River, populated by Aryan tribes, invaded by nomadic peoples and dominated, for many years, by the Arab people. India has always been viewed as a desirable location for navigators, its geographically strategic location for navigations in antiquity took it today to the tenth place in the world economy.

Currently, India's growth has taken an important leap in its economy, occupying the position of the second fastest growing economy, due to government actions. This being a notorious result, given that an economic leap like this given by India is of paramount importance, because, in the face of a vertical analysis, it shows that the active participation of a State before its government is

preponderantly relevant. Since it sought in its adversities, such as the monsoons, which generate often catastrophic results, an adjustment of its investments for society, and which, if well planned, result, in the long and short term, in an active and sustainable society and, thus, eradicating the problem of food shortages and poverty.

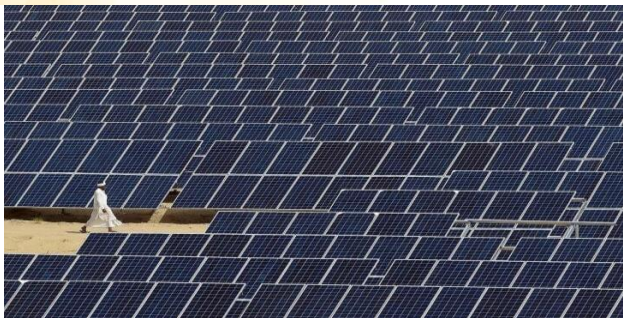
Due to its geographical position, India is annually affected by a climatic phenomenon called monsoon, which has its advantages and disadvantages. Faced with the exposure of this phenomenon, which lasts 4 months, from June to September, India becomes practically immersed by the amount of rain that falls on its territory, but in the rest of the months it suffers from overwhelming droughts. Currently, the sovereign State of India has been developing modern social policies that gradually come with a growing economy and a timid eradication of poverty. The monsoon period causes the water table to increase its reserve through the absorption of rainwater, which penetrates the earth, runs through rocks until creating these pockets of clean water. In a visionary attitude, the Indian government developed smart solutions so that this water could be reused.

The current system used in India is the implementation of solar pumps, which do not generate greenhouse gases because their energy comes from a clean, natural way, from the sun's rays. The generated energy is able to pump the water, taking it to irrigate the plantations, further promoting the agricultural economy. Based on this premise, we can understand that it is a natural cycle, that is, abundant rain absorbed by the earth, filtered by the rocks, stored naturally and transported to the Indian people. This stored water conserves healthy nutrients whose food is rich in vitamins and has no chemical element harmful to human beings, which is what happens with water from dams and treatment plants.

The socio-economic and sustainable process in India has achieved its objective effectively as per the results in the economic ranking. Two measures of applicability were fundamental for the perfect performance, which are:

> **1st) -** The capture of underground water in a clean and sustainable way with the implementation of solar pumps, and installation of photovoltaic panels to capture the generated solar energy.

Photovoltaic panels have the ability to absorb the sun's rays in order to generate energy, in this way the energy passes through a converter, aligning it with the energy generated in the local electrical grid. In addition to conversion for use, the surplus is transferred to the power plant, generating credits. It is only at night that there is no energy generation, however, during the day, on days when the sky is overcast, cloudy or even rainy, solar energy is generated, of course with less intensity.



https://www.hypeness.com.br/2018/04/india-ja-tem-sua-primeira-cidade-funcionando-100-com-energia-solar/

The Indian state provides its citizens with a subsidy so that farmers can have economic access and thus make the necessary installations for the implementation of solar pumps and photovoltaic panels. The government pays from 30% to 70% to install this system. The applicability of this system is pushing India out of poverty and satisfying the hunger of over 1.339 billion Indians.

2nd) – Sustainable method by drip irrigation

This method occurs through the implementation of a modern Israeli drip irrigation system, which avoids wastage in water consumption. To understand the method, we must understand the cycle that develops around this situation. The water is absorbed by the root of the plant, without soaking it and so the cycle is perpetuated, as the dripping water penetrates the soil and the planted food absorbs only the necessary nutrients and the rest of the water penetrates the soil, being filtered by the rocks and again it acquires nutrients and forms new pockets of water.

https://www.canalrural.com.br/noticias/irrigacao-por-gotejamento-reduz-gastos-pode-dobrar-produtividade-67435/
Fonte: Marcelino Ribeiro/EMBRAPA

It is a modern and sustainable vision that, in the short term, brings beneficial health results, to a nutrient-rich diet, and, in the long term, the world climate would slow down as the levels of greenhouse gas emissions would decrease.

4.3 ENVIRONMENTAL IMPACT WITHIN UNIVERSITIES

The studies, carried out by university students at the University of Keele, in England, sought to put into practice methods of sustainability, which in addition to reducing costs for educational institutions, could also broadly and sustainably support the local economy and the environment. This university has been operating in the education network since 1949 and today has approximately 8,302 college students who felt the need to pursue this sustainable path.

The university created research data, so that they could also serve as prototypes for application in other academic centers. Throughout the course, the steps put into practice and the action measures were always linked to the clarification of the facts so that the academic community could understand the great magnitude as above. Here are some measurements that are exposed in the test data:

1 – Discarded food: residues from food are separated and directed to anaerobic digestion, which is the chemical fermentation of these wastes that become fertilizer, that is, made a land rich in proteins and ready for planting;

2 – Waste for recycling – these are materials that can be reused, such as paper, cardboard, PET bottles, soda cans or other products, plastic and other materials that can be reused;

3 – Drinking water: with the implementation of solar pumps and photovoltaic panels to capture water from rain and mainly from the thaw after the long winter period;

4 – Water treatment: creation of a water treatment plant from the discharges carried out in the bathrooms, and also those used in the washbasins. This method treats the water and returns it for use in the discharges, generating a positive cycle of reuse without waste.

The test data seek to support all universities that look for to reduce their economic costs, however, with solutions aimed at the common good.

Given the current economic and social scenario, universities are considered large centers of agglomeration of young people and adults on a continuous and constant basis due to the classroom lessons. Based on this, it is clear that the use of energy, water and food intake is fundamental and it results in huge local consumption.

> Article 1 of the Federal Constitution of 1988: I - build a free, fair and solidary society; II - guarantee national development; III - eradicate poverty and marginalization and reduce social and regional inequalities.

The aforementioned Brazilian constitutional text is exhaustive regarding the guarantees of building a healthy society, developed with the aim of always seeking the supremacy of the public interest, so it is relevant to apply methods performed in other institutions as the Keele University in England that sought in the daily routine of an academic such as drinking water from drinking fountains, or even in the simple daily routine of personal hygiene using bathrooms, washbasins and others. It is understandable that the economic expenses arising from the fundamental daily life of an academic within the campus of his university is something that generates a great financial impact that ends up also reflecting in the costs of the monthly fees paid.

5 COMPARISON OF THE ARTICLES WITH THE CURRENT SITUATION IN THE AMREC REGION

The main objective of this study was to analyze the methods that some countries applied years ago in order to identify what is beneficial, and thus, be able to sequence them in the southern region of Santa Catarina. However, the scenario in Brazil needs to advance, as reported in the book "Climate changes and political responses in cities: The risks in Baixada Santista", by Fabiana Barbi. For the author, the results of local research indicate that the applicability of new actions in a global system as a whole is possible. However, systems adopted without national strategic planning bring negative consequences such as the emission of polluting gases (the greenhouse gas).

In the current conjuncture, there are countless social manifestations allied to public policies that applied in a socioeconomic and visionary way by the current governments, but often seen from an erroneous perspective, are gradually generating results with immeasurable benefits.

In the search to compare these strategies used in countries such as Spain, India and in the Keele University, in England, to the region of the Municipal Association of the Carboniferous Region (AMREC), which is formed by 12 municipalities, where each city performs its socials and economic function. Thus the aim is to generate a common interest among the aggregated municipalities, such as the creation of dams that may meet the entire demand of the region.

The Aguaí reserve located in the municipality of Siderópolis is the place of São Bento River Dam. The construction of this dam followed all the environmental standards required and supervised by the Environment Foundation (FATMA), currently the Environment Institute (IMA). However, one cannot exempt or evade knowledge regarding the imbalance of the ecosystem and, also, regarding the emotional part of the inhabitants who lived there. When analyzing the effectiveness of the construction of the dam in tandem with the new policies of evolution in agriculture that is the installation of solar pumps, the results would be totally adverse. In the economic scope even the implantation and

installation of these pumps and photovoltaic panels would still make less costly than the traditional construction of dams, as exposed in the studies developed by João Tavares and Galdino et al, in their work entitled: “Engineering Manual for Photovoltaic Systems, March 2014, with resources subsidized by the Ministry of Mines and Energy (MMS).

To a construction of a dam, it is necessary to relocate the riverside people to other locations, as well as to reimbursement the pecuniary value in currency, as occurred in the municipality of Siderópolis, thus following what is expressed in our " Magna Carta", as follows:

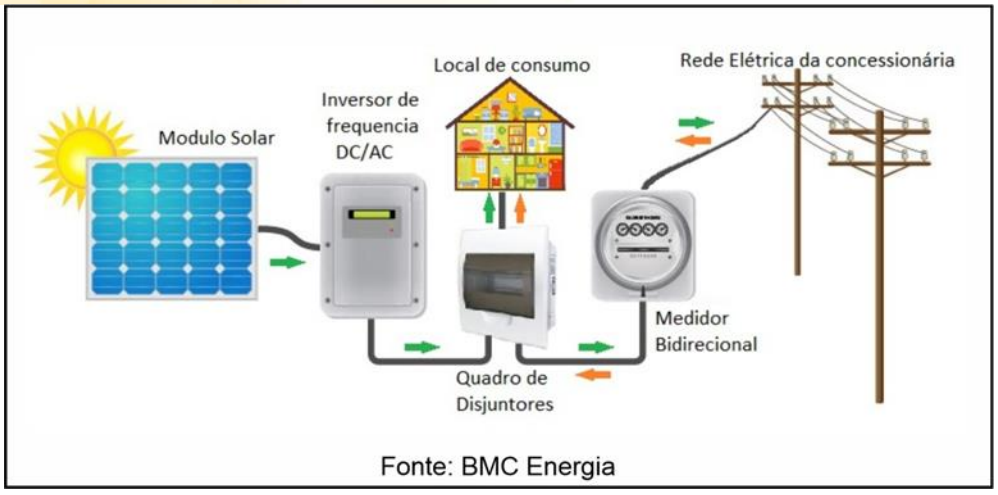
> Article 5, item XXIV, of the Federal Constitution of 1988: Art. 5th All are equal by the law, without distinction of any nature, guaranteeing to Brazilians and foreigners residing in the country the inviolability of the right to life, liberty, equality, security and property, in the following terms: XXIV - the law will establish the procedure for expropriation for public need or utility, or for social interest, upon fair and prior compensation in money, except in the cases provided for in this Constitution.

Based on this assumption, the construction of a dam causes damage not only to the public funds, but also to the ecosystem, through the extinction of local flora and fauna, such as the primate Buggio (monkey) that lost its habitat and now has its name on the list of extinct animals, as reported by those responsible for the “Maracajá Ecological Park”, which now houses these animals.

In the city of Urussanga, there is already an agricultural company that has implemented this system and installed solar pumps and photovoltaic panels, as explained by the finance manager of German Solar Energy (GSE), Érica Fontanella, responsible for the implementation. She reported that results in the economic sphere are notorious, when it comes to energy costs, since this system suppresses expenses of electricity and water consumption from treatment companies, as a result of the use of solar pumps. According to her, it is remarkable the quality of fruit and vegetable products, as they have a unique nutritional quality.

Another extremely relevant point will be the study of a possible applicability of the sustainable WEF nexus, at Unesc’ campus, a university that today has more than 12,700 college students, apart from collaborators and professor. Unesc currently has 50% (fifty percent) more students than the aforementioned English institution.

The geographic location of Brazil is significant and has an advantage over other States (Spain, India and England). If we analyze the period, for example, of the university recess in summer, the absorption of energy by the photovoltaic panels will be stored for use during the school year.



Fonte: BMC Energia

Therefore, when we go deeper into this new mechanism, we can understand that the results are positive in short terms and benefits are tremendous in long terms.

6 CONCLUSION

The main goal of this study was to better understand the methods that some countries applied years ago and that today are at the mercy of the outcomes that are shown to be negative, as they were systems adopted without strategic planning, which we can call master plan. Spain and its construction of dams left it in a comfortable situation, however, it is noted that the results are becoming even more negative, as in addition to contributing to the increase in the emission of greenhouse gases, it is still affected by a relevant change. With the imbalance in its climate, which is causing lack of water. There are sources that are drying up, even causing Spain to break treaties made with Portugal on the construction of dams together, but as the springs are located in Spanish territory, it ends up locking the floodgates that stop the water that would have its final destination in the country neighbor, Portugal. During all the studies carried out, it can be understood that if decision-making attitudes had the support and help of their leaders, the result would be much faster and more effective.

Regarding the economic leap that India has been making in recent years, it is notable that these measures are peremptory, as in addition to being in the ranking as the tenth place in the economic category. India was also the second fastest growing economy in the last year.The numbers are real, the math is simple and notorious. Subsidizing such a sustainable event, taking food to all parts of its territory, is something remarkable, even more so when taking advantage of a climatic phenomenon that cannot be dodge, but intelligent attitudes transform precarious situations into positive actions that serve an entire population. Correct policies generate effective results.

Another relevant point of this research was the great effort of Keele University in England, which sought not only to create sustainable measures to be applied in its institution, but also, creating

research data to serve as a pioneering study so that other universities can take advantage from these methods.With the reading and study of this mechanism, it is clear that academic campuses have become an environment where there is an alarming use of the nexus of energy, food and water due to exacerbated consumption. The Keele University, through its research, applied effective methods such as the reuse of water from the flushes, and lavatory, making that after the period pertinent to the specific treatment, the water returned to the same reservoirs of discharge and lavatory, thus being reused and diluting the waste. Another effective and adopted measure was the separation of food remains so that during the anaerobic digestion that occurs naturally, it could originate in a natural fertilizers, which would fertilize the land for a perfect fruit and vegetable harvest in general. With regard to energy capture, the installation of photovoltaic panels are essential instruments for global sustainability, as an efficient and positive cycle revolves around them, with exemplary care for our solar system, which makes us thinkers and citizens who seek to improve a society as immense as our planet earth.

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