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Most Significant Economic Conditions Associated with the Greater use of Solar Energy in Cuba

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Abstract: The sustainability of the supply of electrical energy at favorable levels for growing and sustainable human development in the current context is in question due to the accelerated depletion of fossil fuels for electrical generation. Therefore, it is pertinent from the country's senior management to develop a global strategy that favors the gradual replacement of the consumption of fossil fuels for electricity generation with technologies that use solar energy as a basis for electricity generation. Describe some of the most significant economic conditions associated with the greater use of solar energy in Cuba for human development. A descriptive observational study was carried out of some of the main conditions existing in Cuba for the greater use of photovoltaic solar energy for electrical consumption. For this, scientific observation and bibliographic review were used as scientific methods. The strategy of emigration from electricity generation with fossil fuel to generation with photovoltaic panels in Cuba must be thought, planned, planned and executed from the convergence of national and foreign economic interests. Committing to the greater use of photovoltaic solar panels does not mean giving up conventional sources for electricity generation, but rather diversifying the national energy matrix in pursuit of greater economic, political and social benefits. To this end, the ingenuity of human resources to adapt to any scenario, together with the motivational benefits for domestic and foreign capital, can constitute the most complete formula to stimulate the greatest possible participation in electricity generation with photovoltaic solar panels in Cuba.

Keywords: Photovoltaic solar energy, Economic conditions, Economic infrastructure

1. Introduction

Sustainable human development is conditional on economic growth based on solid economic infrastructures. One of the main infrastructures of any economy in the current context is electricity.

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This has such an impact on the modern economy that development is currently inconceivable in the absence of electrical energy. At the same time, human development must be ascending and sustained. To this end, a similar behavior of demand towards economic infrastructures is foreseeable, which includes electrical energy [1]. The sustainability of the supply of electrical energy at favorable levels for growing and sustainable human development in the current context is in question due to the accelerated depletion of fossil fuels for electrical generation. Therefore, the introduction of alternative sources for electricity generation is of greater importance to the extent that the scenario for electricity generation with fossil fuel is more critical [2]. One of the best-known alternatives today is that offered by renewable energy sources. Due to their natural condition, they are environmentally friendly, which guarantees a favorable relationship between

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society and the environment, both for present and future generations. They also constitute a first-hand economic alternative due to their diversity, which allows them to adapt and adjust to almost all climatic contexts [3].

Among renewable energy sources, one of the best known is solar. Of the energy obtained from the Astro King, a part can be transformed into electrical energy, so that solar energy has emerged as an important resource in countries whose geographical location is between the two tropics, as is the case of Cuba [4]. All countries in this geographical location are underdeveloped. Therefore, the deformed economic infrastructure that characterizes them is usually accompanied by other economic, political, financial, social and environmental elements that have a direct unfavorable impact on the extensive use of photovoltaic solar energy to replace electrical energy generated with fuel fossils.

In the Cuban case, it is necessary to highlight the high commitment of government authorities to sustainable human development. Therefore, it is pertinent from the country's senior management to develop a global strategy that favors the gradual replacement of the consumption of fossil fuels for electricity generation with technologies that use solar energy as a basis for electricity generation. One of the most important determinants of this strategy is the set of existing economic conditions. Therefore, it is necessary to describe some of the most significant economic conditions associated with the greater use of solar energy in Cuba for human development [5].

The remaining paper is organized as follows. Section 2 presents materials and methods, the results are presented in Section 3, and lastly the conclusions are drawn in Section 4.

2. Materials and methods

A descriptive observational study was carried out of some of the main conditions existing in Cuba for the greater use of photovoltaic solar energy for electrical consumption. For this, scientific observation and bibliographic review were used as scientific methods.

3. Results

The electrical service of any economy is very closely related to the potential of economic and social development. Therefore, guaranteeing electricity consumption in accordance with present and future demand is a guarantee for this development. Cuba is an example of this. The introduction of electric transportation supported by the use of photovoltaic solar energy in large vital services companies such as Aguas de La Habana and ETECSA, is an example of the benefit of renewable energy sources for business and human development. As a generalization, the alliance of the Cuban company CEDAI with the international project “Energy Efficient Buildings” (also known as the 3E project) in the Cuban capital is evident that the Cuban business sector has a lot of benefits through the exploitation of photovoltaic solar energy. The association with foreign capital also favors that Vehicles of the Caribbean (VEDCA), a commercial brand that emerged from an international economic association as a form of foreign investment, has found in the Cuban domestic market a virgin market niche with the potential for exponential expansion of the use of electric vehicles in different formats. These examples show that the use of electrical energy is closely related to a sustainable form of human development for Cuba. Therefore, the way in which this energy is produced, distributed, commercialized and consumed will determine the particularities of human development in Cuba [6].

One of the most significant elements for electricity consumption in Cuba has to do with the composition and structure of the current energy matrix. At present, fossil fuels guarantee 9 of every 10 kW consumed in Cuba. As a consequence, an important part of their combustion is emitted into the atmosphere in the form of polluting elements, particularly in the form of CO_2. This fact has a significant impact on morbidity and mortality from non-communicable diseases, particularly respiratory diseases, from which Cuba is no stranger [7]. On the other hand, the availability of domestic crude oil for electricity generation is limited. This only covers a small part of the current national demand. Furthermore, the current conditions of the Cuban economy have led to the exploitation of these natural resources being carried out with foreign capital, which

constitutes a national opportunity cost due to the consequent issuance of international currencies to the countries of the foreign investor. Furthermore, the impact of the policy of the government of the United States of America towards Cuba means that access to international financial resources is increasingly difficult. Therefore, the availability of alternative sources of electricity generation, beyond any particular economic or financial benefit, is an indispensable element associated with national sovereignty, which is of greater importance to the extent that these adverse elements become more acute [8].

In meeting the Millennium Development Goals until 2030, the use of renewable energy sources plays a fundamental role in the sustainability of human development, by facilitating the replacement of fossil fuels with clean energy. Furthermore, these energy sources can become an important source of employment and family income. In the case of Cuba, the good climate favors the use of photovoltaic solar energy for the generation of electricity. On average, Cuba can have five hours of peak electricity generation with this source, which includes the maximum level of electricity consumption at noon. Furthermore, due to its geographical position in the Tropic of Cancer, Cuba can have 330 – 350 days of annual electricity generation with photovoltaic solar panels. These weather conditions are very favorable for the national strategy of technological emigration towards electricity generation with photovoltaic solar panels [9]. The reduction in fossil fuel consumption in daytime generation could be allocated to nighttime consumption, which is greater than daytime consumption, both in financial terms and in terms of price and physical units. As a result, the amount of fossil fuel import substitution would be reduced, which would contribute to improving internal finances, due to the favorable impact it would have on the Capital Balance. As part of the economic policies in Cuba to support human development, electricity consumption is subsidized. As a result, the price of final consumption is perceived as lower than the real price. This is a fundamental element that distorts the perception of the economic benefits of using electrical energy generated with photovoltaic solar panels to the detriment of that generated with fossil fuels [10]. It should be noted that the perceived price of electricity consumption would be given by the difference between the final price of consumption and the subsidy offered by the current fiscal policy. Currently, the production cost in Cuban thermoelectric plants exceeds 10 CUP/kW. If a commercial margin of 10% is added to this, the generation sales price would rise to 11 CUP/kW. If a transmission loss of 14% of generation is also considered, then the average price of final consumption would be 12.80 CUP/kW. Taking into account that on average, Cuban households barely pay up to 4 CUP/kW, then the subsidy offered by the Cuban fiscal policy to the final consumption of electricity represents more than double what Cuban households pay in general. On the other hand, the useful life of photovoltaic technology reaches 25 years. Given that maintenance costs are low, when exclusively considering depreciation costs at a rate of 4% that covers the entire technological useful life, the cost of generation with photovoltaic solar panels in Cuba would amount to 6 – 6.50 CUP /kW, cost even higher than the average perceived by the residential sector. If a linear depreciation of 6% per year had been considered for technological equipment, then this cost would rise to 9 – 9.75 CUP/kW. Therefore, the current tax policy distorts the economic perception of households, by emphasizing the idea that it is preferable to continue consuming energy from the National Electroenergy System supported by fossil fuels, than to generate electricity with photovoltaic solar panels [11].

In Cuba, the residential sector is the largest consumer of electrical energy. This is fundamentally included in households. The non-residential sector essentially comprises the state sector of the economy, which in turn can be disaggregated into business and budgeted [12]. The sustainability of the process of generalization of the use of photovoltaic solar energy in Cuba is limited to various elements. Among them there are physical factors of the environment and economic factors. The first are given by the natural capacity that the climate offers to use solar energy for the generation of electricity. Within economic factors there is a wide range of elements, among which are the following:

- Infrastructure for the production, distribution, marketing and consumption of electricity with photovoltaic solar panels.

- Effective accessibility to photovoltaic solar panel technology.

In Cuba there are favorable conditions of productive, distribution and marketing infrastructure to undertake a process of gradual generalization of photovoltaic solar panel technology, led by the GELECT business group. In the case of consumption, the physical conditions of the final consumer will determine their own ability to assimilate this technology. In the urban context, the installation of photovoltaic solar panels on the roof of buildings would be more common, while in the rural context their installation on the ground could be more common. Therefore, it is pertinent to carry out a priori professional evaluation, case by case, of the existing conditions for the installation of photovoltaic solar panels on the roof of buildings and/or on the available land [13].

The acquisition of photovoltaic solar panels is an economic decision that involves deciding between current and future consumption. In this sense, the benefit that the acquisition of photovoltaic solar panels should offer at present must be greater than the value of the sacrifice perceived by giving up said consumption. Therefore, the average cost of electricity generation with photovoltaic solar panels must be lower than the price perceived by the final consumer from electricity generation with fossil fuel. For the budgeted sector of the economy, under current conditions, the installation of photovoltaic solar panels does not offer benefits other than the fiscal ones derived from this decision. For this reason, the administration of this sector does not find any additional economic motivation that contributes to the acquisition of photovoltaic solar panels for electrical consumption. An opportunity study carried out by four Havana hospitals, showed that the economic cost of exploiting solar panels on the roof of these facilities is lower than the average price received by these hospitals for the consumption supported by the National Electroenergy System [14]. The use of solar panels in this context would bring additional benefits due to the improvement of the service provided in these secondary and tertiary care hospital facilities. However, the distortion introduced by the fiscal policy on electricity consumption means that, from the point of view of these institutions, the proposed investment is not advisable, based on the results of the corresponding opportunity study. In this same research, these authors demonstrate that without considering the effects of the aforementioned subsidy policy, the use of photovoltaic solar panels is more beneficial. This same idea was presented by the same authors in a pre-feasibility study carried out for the "10 de Octubre" Faculty of Medical Sciences with similar results [15].

Salary constitutes today, more than ever, the fundamental gauge of labor fluctuation in Cuba, with the budgeted sector of the economy being the most affected. Therefore, if this sector could count on the economic benefits obtained from electricity generation with photovoltaic solar panels to distribute them as income among its workers, the real salary would increase and labor fluctuation would decrease. In turn, the administration of this sector would not see it as another workload, but as a viable alternative that contributes to improving the economic activity it manages by increasing the real salary of all workers. In the case of the residential sector, the acquisition of a single photovoltaic panel can represent the individual salary of 4 years or more. Therefore, without the support of commercial banks that contribute to financing the acquisition of this technology, the widespread use of photovoltaic solar panels would be almost impossible. Furthermore, if this sector does not obtain a strong enough motivation, even when the cost of generation with photovoltaic solar panels is lower than the perceived cost of its electrical consumption, the generalization of this technology would be significantly compromised.

The business sector does not escape this distortion, as it faces conditions similar to those that households must face today. However, this sector faces a higher cost not yet described. As part of the national strategy for the rational consumption of fossil fuels in electricity generation, many legal entities have adopted the measure of significantly restricting electricity consumption during peak electricity consumption hours. This has led to the suspension of the service as an administrative measure in many industrial and productive processes in general. As a consequence, there is a significant impact on the potential reduction of national productive capacities, which puts downward pressure on the national supply of these goods and services, which in turn, is

an element that favors the increase in individual willingness. to pay more per unit of consumption, which would translate into inflation. In addition, the reduction in production also has an unfavorable impact on business finances due to reduced profits. This restricts the process of expanded reproduction of capital and reduces the real salary of workers, which is another incentive to exacerbate the process of labor fluctuation in the business sector [16].

The Cuban business sector has been a leader in identifying the benefits of photovoltaic solar energy and using it to its advantage. In addition to the aforementioned elements, the smokeless industry has used this energy in hotel accommodations to provide hot water to guests. However, the conditions of the current economic context do not favor a more extensive use of electricity generation with photovoltaic solar panels. The labor issue in Cuba is very sensitive because the economically active population that is not linked to work is greater than that which is unemployed. That is to say, the persistence of labor potential is observed without sufficient incentive to enter the labor market, among other reasons, because the real salary offered does not meet their expectations. Therefore, the transition from the consumption of fossil fuel for electricity generation to the use of photovoltaic solar energy as a general socioeconomic policy would allow its benefits to be used to stimulate labor productivity through an increase in real wages [17]. Given these conditions and without interfering with the main social objectives pursued by fiscal policy in this sense, it is necessary to establish a differentiated economic policy that favors the acquisition of photovoltaic solar panels for the partial replacement of fossil fuel by photovoltaic solar panels for electricity generation. This policy must achieve the conscientious and motivating convergence of all parties involved. Although the conditions of the national industry for these purposes are very favorable, they are not sufficient, since the fundamental components must be imported to complete the production and marketing process in the domestic market.

Although Cuba's access to the international capital market is very restricted by the sustained policy of the government of the United States of America, there is significant potential for access to these resources under the negotiating premise of win-win. An example of this is the economic intention of large economies such as China and Iran to negotiate with Cuba in this regard. In particular, the association with economies that have external debt compensation agreements would favor the industrial process of production and marketing of photovoltaic solar panels in the national economy. In this sense and as part of said strategy, it would be suggestive in a first stage, to reasonably exhaust the availability of nationally invoiced photovoltaic solar panels, with priority in the budgeted sector and under the premise of using the compensation fund of the external debt for these purposes. In this way, the national industry would have a significant volume of liquidity that would favor it to meet the financial commitments quoted in CUP to correspond to the subsequent demand of the process of generalization of the technology for electricity generation with solar panels. This negotiation with the external debt compensation fund would significantly benefit the budgeted sector, because being part of the sector supported by fiscal resources, the contribution of depreciation to the fiscal budget would not be relevant. Furthermore, as operating costs are reduced, the economic benefit obtained by this economic sector would be optimized with the installation of photovoltaic solar panels for electricity generation [18].

Therefore, the strategy of emigration from electricity generation with fossil fuel to generation with photovoltaic panels in Cuba must be thought, planned, planned and executed from the convergence of national and foreign economic interests. This strategy can gain dynamism if it places man at the center of its interests as the fundamental object and subject of this strategy in pursuit of human development. To this end, it is pertinent that this strategy foresees the growth in demand for electricity consumption during daytime hours and evaluates the possibility of greater concentration of industrial and productive activities during this time due to electricity generation with photovoltaic solar panels. To do this, it would be necessary to create a technological infrastructure based on this renewable source of energy, which in accordance with the demand of economic development, allows the gradual replacement of electricity consumption generated with

fossil fuels by electricity consumption generated with photovoltaic solar panels.

4. Conclusions

Committing to the greater use of photovoltaic solar panels does not mean giving up conventional sources for electricity generation, but rather diversifying the national energy matrix in pursuit of greater economic, political and social benefits. To this end, the ingenuity of human resources to adapt to any scenario, together with the motivational benefits for domestic and foreign capital, can constitute the most complete formula to stimulate the greatest possible participation in electricity generation with photovoltaic solar panels in Cuba.

Conflict of Interest

Author declared "No conflict of interest".

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