

PHOTOVOLTAIC SOLAR ENERGY CONTRIBUTION FOR AMAZON'S COMPANIES

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ABSTRACT

This study shows the process of innovation as a business strategy through the use of photovoltaic solar energy in industrial enterprises in the Amazon. The study is based on the classical theory of common goods (see Filipe, 2006 and Filipe *et al*, 2007) and intends to analyze the need of the contemporary world in finding clean alternatives for supply energy for the production of goods and services in the economy. It analyzes also how this process influences customers' minds in an business-friendly environment in the Amazon region. The study permits to conclude that the implementation of solar energy in companies in Amazon region generates competitive advantages in the market.

Keywords: Innovation, commons, Amazon, solar energy.

1. INTRODUCTION

Commons have long been a central theme in natural resources economics (see, for example, Copeland & Taylor, 2009) and are often discussed in problems of efficiency of resources' utilization. The second half of the 20th century demonstrated the considerable problems caused by under-defined property rights for commons (Alchian & Demsetz, 1971; Demsetz, 1967). This kind of situations may represent an inefficient use of the resources and has generated tragedies around the world (Filipe, Coelho & Ferreira, 2007). The Hardin's metaphor "tragedy of the commons" (Hardin, 1968) is a reference in the study of the problem of the commons in several areas, such as the overexploitation and extinction of species, the problems about human overpopulation, prices externalities, oligopoly behaviour, global warming or air pollution. The problem is that people usually have no incentives to preserve the common areas and common resources and often overuse them (Bjorndal & Conrad, 1987).

The contemporary world community is facing an obvious need to seek alternatives to produce goods and services in ways less damaging to the environment. The use of photovoltaic solar energy comes as a possible contribution to solve some environmental hurts. The use of such energy comes not only to ensure a clean and responsible production, but also permits to work the possibility of generating competitive advantage in the market due to its innovative character, breaking the *status quo* in the market.

This study is divided into six chapters. After the Introduction, in the chapter two, solar energy as a business strategy is analyzed. Specifically, solar energy can be seen as an innovation and as a possibility to generate competitive advantage in business. It may generate market differentiation and a reduction in production costs.

In the third chapter the problem of "Drama of the Commons" is presented, highlighting the dilemma about the allocation of natural resources and the way how economic agents are related to production, taking into account the property rights, externalities and the importance of using clean sources of energy in the production of goods and services in the economy.

The fourth chapter presents a brief historical narrative of the industrialization process in the world, in Brazil and in the Amazon region and shows how companies participate in the Amazon industry when solar photovoltaic energy is incorporated in the industrial process.

The fifth chapter consists on the presentation of results showing how customers of industrial enterprises in the Amazon consider the use of photovoltaic solar energy to produce goods and services.

Finally, the sixth chapter addresses some concluding remarks of the study, taking into account the results regarding the use of solar photovoltaic energy in industry companies in the Amazon.

2. SOLAR ENERGY AS A BUSINESS STRATEGY

Currently, companies need to be well prepared in the highly competitive global market. This competition is now based on the innovation capacity of production units. The use of photovoltaic solar energy in goods' production as an innovation on the market may work as a competitive advantage for the firm.

As Kelly and Kelly (1995, p. 207) note, each company must develop its capacity to innovate in the market, by trying to develop new processes and gaining advantages at least in the short term. The ability to innovate may generate competitive advantages for the company in the market through differentiation from other competitors. By doing this, it is acceptable to consider that other companies follow the leader, which has created the referred innovation in a particular market. If the company expects to be competitive and successful in the market, it is necessary that it keeps the capability of generating economic value. The company shall keep ready to innovate once again assuring that it will remain ahead from its competitors.

If the company is innovative and capable to be adaptive to the market, it will have high productivity levels and will be efficient and effective on its operations. However, this company has no guarantees for success. All factors of competitiveness must be worked. For sustainable position in the market the company shall be also concerned with the sector's social environment in which it operates and social responsibility in a large extent. A very interesting way to do so is to be responsible when the company uses common resources, without harming the environment and ensuring its use by future generations.

When there is such a social concern, it is needed first and foremost that the company has to be aware that there are balances at risk, which effects can be unpredictable. There are many situations of excessive and harmful environmental degradation. Quality of environment and biodiversity are capital to mankind and it is essential to avoid and to fight against their damage and degradation. Any kind of reorganization and restructuring of nature's processes may need a long time to take place and to find new instances for stabilization (see Filipe, 2006, p. 59).

Innovations may contribute for the competitiveness of the company. For that, company should strive for optimizing its profits. Competitive advantage is often reflected on the reduction in production costs. To understand the cost of production, according to Varian (2006, p. 386) "the function of short-term cost is defined as the minimum cost to achieve a given level of output through only the adjustment of the variables representing the factors of production.

Costs are generally divided in two types, fixed and variable. Fixed costs are the ones that remain constant regardless of the degree of occupancy of the productive capacity of the company. Costs are derived from the existence of the company. On the other hand, variable costs are the costs that depend on the firm's occupation degree of productive factors. To Sandroni (2007, p. 219), they are part of the total cost that varies with the degree of occupancy of the productive capacity of the company: for example, cost of raw materials, wages for the production and others.

Considering the concept of cost, it may be said that the cost resulting from the use of photovoltaic energy may be considered a fixed cost (considering its installation with the resulting spending on equipment needed to generate this energy), and similarly as variable cost, because of the variation on the use of energy generated, that will logically vary according to the resources allocation and the level of production.

Type of energy	Cost per kWh (€)
Electricity Network	0,12
Photovoltaics (panel silicon)	3,75
Photovoltaics (nano-panel)	0,34

Fig. 1. Cost per type of energy

Source: Adapted from *Scientific American*, 2008.

Figure 1 shows the costs related to the use of some types of energy, electric energy network, solar photovoltaic silicon panels and power generated by photovoltaic nano-panels. Solar nano-panels are well positioned in the perspective of costs. Therefore, cheaper energy means reduced variable costs. Compared with the use of energy provided by the local public network, the energy from the solar panels still has a higher relative cost of operation. However, the difference of costs between them has been falling consistently, even when compared with the energy generated by solar photovoltaic silicon panels, which has a higher cost than the energy generated by nano-panels.

Besides that, there are costs generated by hydropower that are subjective, since they affect the environment in which the entrepreneur operates. Allied to this, in Brazil a strong trend of increasing costs to the production of hydroelectric power is observed. The comparison of the hydroelectric energy produced in Brazil and other countries like Canada, for example, shows the importance of the development of alternative energies. In Brazil, the behavior of the total cost of producing energy used to be well above inflation in the country for a long period¹. Recently, Brazil took the advantage of using photovoltaic energy through the use of nano-panels. It may be noted in fact that this is one of the reasons that qualify the use of photovoltaic energy as a generator of competitive advantage in the market. The company which owns such technology may experience a reduction on its variable costs, compared with solar photovoltaic panels (silicon). Nano-panels permit also to perceive a competitive advantage in environmental conservation terms, when compared with the energy provided by public network.

Considering the business competitiveness with respect to the utilization of solar energy, competitive advantages can be represented not just by the growth in revenues arising from social perception of the community regarding the fact that the companies are environmentally friendly, but also by reducing costs through the use of a type of alternative energy that is cheaper to produce goods and services.

3. THE DRAMA OF COMMON RESOURCES

According to Filipe (2006) and Filipe, Coelho and Ferreira (2007), the Drama of Common Resources shows the magnitude of the problems arising from the use of the global commons and how it relates to the production in contemporary society. The world population continues to grow and the average age of life of individuals is

¹ The average tariff for electricity in Brazil showed an increase of 68% over inflation in the period 1995 to 2005; the industry had a difference of 78% over the same period of 10 years; in the commerce there was a difference of 30% in the increase in fares paid in respect of inflation; and the housing market showed a difference of 62% (see Webber, 2008, p. 28).

increasing significantly. This fact jeopardizes the proper use of common resources, because of the pressure exercised on the use of the resources (see Filipe *et al*, 2007, p. 247).

Considering the concept of ownership, it may be said that the property is defined by its inherent characteristics in relation to the object, but especially for including the relationship among individuals. According to Filipe *et al* (2007, p. 84) it should be noted the importance of property rights in respect to common resources, as in relation to natural resources in general. There is also a matter of efficiency and externalities in property subjects. Through property rights contextualization, the actions of individuals generate effects and have implications that are reflected on the affectation of resources and sometimes have inefficient external effects on the underlying activity that have generated them.

It is claimed that the rights relating to private ownership allow the owner to have the exclusive right to exploit a resource. At the same time, respecting assets under common ownership, being held by a group, the individuals who do not belong to the group may be excluded from the exploitation of the resource. Free access in turn is not completely exclusive to the extent that no individual can be denied the use of the resource (see Filipe *et al*, 2007, p. 85).

After explaining some characteristics underlying the property rights and ownership relation and after considering some notes on common goods, let see the regimes of common property. Berkes and Farvar (1989), cited by Filipe *et al* (2007, p. 50) classify the regimes of common property resources as follows:

- Free access (*res nullius*) - free goods: non-exclusive and non-transferable rights to use the resources, rights possessed in common but free access for everyone (thus being owned by anyone) [...];
- State Property (*res publica*) - ownership, management and control by the state, public resources for which the rights of use and access have not been specified;
- Communal property (*res communes*) - use rights of the resource are controlled by an identifiable group (not privatized or operated by the Government), there are rules about who can use the resource, who is excluded and how it should be used [...].

In a traditional form, as shown, common property refers to the collective ownership of a group, being the group able to exclude non-members / non-owners from the exploitation of assets that are owned and exploited in common by the individuals of the group (see Filipe 2006, p. 51).

Filipe, Coelho and Ferreira (2007) point out the need of using clean sources of energy with potential to meet the productive needs of the economic system, allowing the preservation of the common resources basing the analysis on different perspectives for economic agents.

Considering the analysis of Berkes and Farvar (1989), cited by Filipe *et al* (2007, p. 86), solar energy is a free good, which access is available for everyone. Moreover, solar energy is a good [common] which exploitation potentially permits to preserve other common goods, including fossil energy resources, which exploitation provides externalities to the environment and to the society. By substituting other forms of energy, the exploitation of solar energy, which constitutes a clean energy, contributes to the preservation of other common resources like air, water, etc.

The contribution of solar energy for the competitiveness of enterprises and its contribution to the economic development strength a new hope for the society, as a whole. In particular, it brings a new competitive perspective to companies in Amazon, once the public begins to focus on companies which use clean energy and tend to view these companies as environmentally friendly, benefiting them in the market, in detriment of the most polluting companies. Many recent cases corroborate this statement. It is the case of some large distribution networks that decided to boycott the sale of beef from companies that exploit it in a non-sustainable way in the Amazon rainforest, how it has been the case of the deforestation).

4. PHOTOVOLTAIC SOLAR ENERGY IN THE AMAZON'S INDUSTRY

The structure of the complex forming Barcarena-PA and a brief history of the industrial world, of Brazil and Amazon industrialization processes are presented. The key economic factors that influenced the process of industrialization mainly in Brazil and in the Amazon, emphasizing Barcarena Industrial District in the State of Pará are exposed, as well.

Industry represents a set of productive activities characterized by the transformation of raw materials, manually or with the help of machines and tools, to manufacture goods (see Sandroni, 2007, p. 425). Overall the industry as it is known today began with the industrial revolution¹ (XVIII-XIX centuries), reflecting a process that began with medieval techniques going to production manufacturing. However, its contemporary configuration is characterized by the systematic large-scale production in factories that have standardized products and processes derived from the automation and mechanization of production.

With the industry's transformation, the configuration of countries' productive borders occurred at the same time. Many companies have got the production in a multinational format, what has occurred in all branches of the industry².

Brazil was born as a Portuguese colonial project, and so, under the sign of external dependence. With the economic accession of Portugal to the emerging British capitalism, from the early eighteenth century, based on the

¹ Set of technological, economic and social changes in Europe and particularly in England in the eighteenth and nineteenth centuries, and resulted in the installation of the factory system and the diffusion of capitalist mode of production.

² Industries are distinguished in various branches, as the goods they produce, industrial capital goods (machinery, equipment), intermediate goods industry (raw materials for other companies), consumer goods industry (individual utility articles for family) (see Sandroni, 2007, p. 425).

Treaty of Methuen¹, the new colony was to serve both Portugal (supply of gold) and England, as a channel for industrial products (see Souza, 2007 p. 01).

But with the rising of economic crisis in the 1930s, the agro-exports that were based on coffee and that were tied to the interests of England have collapsed. This fact led Brazil to the resumption of industrialization plan tested in the early republic. The final transition of an agro-economy to an urban-industrial modern economy has become the hallmark of this new period. This period was generally called industrialization through import substitution². Usually Brazilian industrialization had two pillars: the implementation of basic industry³ and the stimulation of the internal market.

This policy has taken place in the whole Brazilian territory - each region with its own peculiarities. In particular in the Amazon city of Barcarena in Pará, which is one of the largest cities in this state, with approximately ninety thousand people, is installed one of the largest industrial centers in the Amazon with 240 ha, an excellent infrastructure which includes the supply of electricity by the hydroelectric Tucuruí, a road system and a port which holds vessels up to 60.000 tons, 250 meters long and depth of 17 meters. The industrial district, where industrialization is made, processes and exports kaolin, alumina, aluminum and cables for power transmission. Moreover, the city retains its traditional economic base, the agriculture, but also advances in tourism and as seen before, with business industries in the city, generating economic growth and development in the Amazon region.

The industrial district Barcarena presents a large number of companies standing out in particular fields of activity, like mining, metallurgy, food, energy, pulp or paper.

Companies need to be dynamic considering the need for the development of innovations and thus creating competitive advantages through their production processes. They can create economic value and reinforce their viability considering the market in which they operate. For McDonough III (2009, p. 04) "in the current economy, very dynamic, organizations must continually reinvent what they are and what they do [...]". This means that they need to constantly maintain market differentiation, through deliberate strategies in order to obtain competitive advantages that provide monopoly profits, even if temporary.

When a company seeks a high level of competitiveness, the company needs to commit with the preservation of the existing common resources. This will allow to optimize commons' uses, considering the availability of resources for future generations and considering the best options to keep resources sustainable. It is no longer possible to count on such a supply of natural resources like the one of the last century to supply the huge demand, given the level of production that humanity has got across the twentieth century.

In the energy market in Brazil, renewable energy has to be characterized as an innovation, contributing for environment and keeping productive efficiency. This contributes to validate the principle that, first, it is necessary a new productive combination and, second, a competitive advantage is generated in a company, which uses it.

The process of using solar energy in the Amazon's companies has become a milestone with regard to environmental responsibility. In this market it has not been usual to use renewable energy for industrial production. Basically, the energy for this kind of business comes mostly from hydroelectric and from thermoelectric plants. These sources are not clean. On the contrary, photovoltaic's energy has been seen as a viable source, and a clean source, for this kind of companies. Accordingly, a company may get an important advantage, especially considering the benefits resulting from the advance in the production process took by the company. In this context, new processes that prepare companies to the future are well recognized in Amazon's region by understanding the way companies get the use of photovoltaic solar energy as a result of the process of innovation to be used in this region.

5. EMPIRICAL STUDY

Taking into account the use of solar photovoltaic energy generated by nano-panels and the effect of this strategy as a source of innovation, it should be considered the consequent creation of a competitive advantage in industry companies from Amazon that choose this strategy. Chavaglia (2010) presents some interesting results coming from competitive advantages for companies that use environmentally friendly energy, in this case, solar photovoltaic energy, generated by nano-panels. This energy is used with results in the production of goods in Amazonian industry. The resulting competitive advantage is represented by effects on the mind of consumers of products of these companies. Note that the customers show:

- a high degree of openness to this form of solar energy generation;
- a high degree of interest in discussing this issue of renewable energy sources;
- a belief that companies that use environmentally friendly energy will have a high profitability;
- a high degree of acceptance of alternative energies in commercial spaces;
- a high degree of satisfaction with the fact that clean energy can be utilized by enterprises;
- the recognition of a differentiation on the market for enterprises that use photovoltaic solar energy produced by nano-panels; and finally,
- to have some suggestions for companies about the use of photovoltaic solar energy, through nano-panels.

¹ Commercial treaty signed in 1703 between Portugal and England, by which Portugal gave preference to British industrial products, while Britain favored the Portuguese wines and olive oil (see Souza, 2007 p. 01).

² Concept developed by economists to describe an internal process of development, stimulated by external imbalance, which results in dynamism, growth and diversification of the industrial sector.

³ Industry that feeds the others (see Sandroni, 2007, p. 425).

The analysis of documents and the approach to industrial customers in the Amazon region allowed to conduct this research in the Industrial District of Barcarena - PA. Customers of the production units were interviewed and a questionnaire was developed considering the deployment process - or deployment simulation - as an innovative strategy, through a supposed injection of photovoltaic energy produced by nano-panels in businesses, in order to understand what is the degree of satisfaction and motivation of customers for these plants. Specifically, a sample of 1.000 customers was collected in industrial enterprises of the Industrial District of Barcarena, in order to work the data and concluding about the perception of satisfaction generated by the use of photovoltaic energy by companies in the industry.

In the formulation of the questionnaire it was intended to identify the effects on business arising from the strategy of product innovation with the use of photovoltaic energy in the production of goods and services. Furthermore, the presentation of the effects of photovoltaic energy production in the company's variable costs, the identification of the effects of the deployment in the mind of enterprises' employees and the demonstration of the consequences of the use of photovoltaic energy by companies in the mind of consumers were examined.

The statements in the questionnaire, applied to companies in the Amazon, were placed in order to follow a degree of "totally dissatisfied" to "completely satisfied" on a scale of 1 to 6, or in some cases 1 to 10. After analyzing the results, in short, it was found that customers are very likely to accept the use of energy produced in a sustainable way, especially with regard to photovoltaics due to the use of nano-panels in the companies' operations in the Amazon region (see Chavaglia, 2010, p. 51).

According to Chavaglia (2010), customers of companies in the Amazon's industry indicate that, when confronted about the degree of openness for renewable energies, are quite favorable to the use of new energies, noting that the Amazonian population encourages the development and the use of renewable energies, which favors the implementation of systems that deal with this type of energy in the Amazon region.

Increasingly there seems to be a full conviction that renewable energy can bring benefits and are an essential element in the development of peoples and civilizations, being necessary to bring new assumptions to companies that encourage new skills, corresponding to an harmonious development. It is therefore possible to conclude that the level of culture and group consciousness developed in this region are consistent with this philosophy and appear sensitive to the needs of developing strategies that enable business growth imbued with a spirit of social and environmental responsibility.

Turning on the degree of customer interest from industrial companies of the Amazon on renewable energy, it seems obvious the idea that they are clearly interested in this subject, having been more than 60% of respondents claiming to have a degree of interest between 8 and 10 (scale 1-10) for renewable energy, showing that the customers of those companies would like to know more about renewable energy. This result suggests the possibility of clarifying the customers about the possibility of using clean energy in the production of goods and services in enterprises. In other words, it suggests the dissemination of more information about this process, allowing business customers to better understand its function and importance to the environment.

It is interesting to note that a large proportion of respondents believe that investments in technologies in the area of renewable energy are profitable, taking into account the responses of these companies' customers (see Chavaglia, 2010).

This idea permits to consider as well that this kind of investments can be very attractive for local business considering also the acceptance that investing in clean energy is well received on the market by the customers. It generates the option for companies to invest in this type of technology without suffering any retaliation concerning the demand for goods and services provided. Thus, there is a reduced risk of acceptance of this new technology on the market. There is, however, to realize the scope of the study and the approach to the respondents. The results presented here do not imply that there is a loyalty purchase by consumers for products and services of the companies in analysis. Sales expectations are related to other variables like the marketing effort, fashion, imperfections of markets, which were not studied in this paper, and so it is not possible to have any additional specific conclusions in this regard.

The use of renewable energy also in commercial spaces seems to indicate the existence of a greater interest in visiting the company, according to the responses of customers (see Chavaglia, 2010). The customers of these productive units of the Amazon show that they recognize the existence of a social factor which could incorporate the social consumption, which is known to exist in some developed countries, including Europe.

With the use of clean energy, environmentally friendly, the idea of creating a competitive advantage seems to arise from the way people perceive the use of renewable energy by companies. As a result, the company is seen as a different company, and more attractive not only in socio-environmental, but also for being "a company oriented towards the common good".

Overall, customers have shown to be quite satisfied with the use of a type of environmentally friendly energy companies (see Chavaglia, 2010). Considering the scale 1-6, 33% of respondents said they hold sixth grade - highest possible grade on this question - satisfaction with the companies that use (or intend to use) a type of environmentally friendly energy, 46% of customers said they hold grade 5 satisfaction, 15% presented grade 4 and the last three grades together comprised only 6% of respondents' answers.

This indicator shows that customers of the production units have high satisfaction with the fact of using one type of alternative energy, environmentally friendly, in the production of goods and services.

The high customer satisfaction in this context is reflected in the companies in two distinct ways. First, through the possibility of being positively perceived in the market, for using a type of environmentally friendly energy. Second, customers believe that solar photovoltaic nano-panels meet the demand of enterprises with regard to the quality of energy supplied, which is enough for customers to maintain a business relationship with these companies.

The capacity of photovoltaic nano-panels to generate competitive advantages for companies, producing through this way goods and services by using environmentally friendly energy, will create a differentiation for their customers. This differentiation is got, in part, through the way this is perceived in the minds of customers. When asked about the use of energy resulting from the installation of nano-photovoltaic panels and if this would imply a differentiation in the marketplace, 74% of customers of these industrial enterprises in the Amazon said that there is a differentiation, ie, by using a kind of environment friendly energy, market differentiation is created (see Chavaglia, 2010). This means that consumers are aware of social responsibility and environmental responsibility, which permits to state that companies that comply with this requirement will be positively perceived, when compared with other companies. This perception of differentiation by agents comes from the need of preserving the environment, considering the real danger of depletion of natural resources of the planet.

6. FINAL NOTES

The ability to generate wealth is the basic assumption of the existence of a company. This study aimed to analyze how the creation of value can result in competitive advantages occurring from innovative strategies based on the application of a form of renewable energy in industrial enterprises in the Amazon. This study permits the analysis of costs for this type of innovation and the degree of satisfaction in the customers of these companies.

The existence of a pragmatic perspective on the analysis of the results took into account the existence of a bias created by the existing economic and cultural diversity in the Amazon region during the application of the questionnaires. Therefore, the understanding of the subject by the respondents was taken into account, knowing that social class, religion, or education, for example, may influence the results as well as their market behavior.

Although the use of renewable energy through photovoltaic nano-panels, in the production of goods and services by industrial enterprises in the Amazon, was viewed "with surprise" but at the same time it has generated a high degree of satisfaction in customers, leading to differentiation and creating competitive advantages, perceived and expected by managers, by using this innovation - photovoltaics energy - as a business strategy.

Based on the abovementioned, it is possible to verify that, adopting the strategy of innovation through the use of solar photovoltaic nano-panels in a company; it is possible to generate advantages in the market, even though the costs of using photovoltaics are still higher than the costs initially generated by the public net. It will be interesting to make investments in this area in the short term because, as can be seen and based on this study, there is full acceptance by customers of the companies studied in this research, which may indicate that acceptance in the future may exist when economic agents have to decide between "environment" and "payments" that have to do to support the service. As the unit costs are going down, the potential of the company which has invested in this area may give effect to, visibly and materializing with, significant increases in sales and results. There are interesting perspectives open and both the company which is available to make these investments and agents who will seek out these products and services will converge in terms of practices of supply and demand. Some will demand for increasing profits by meeting the clients' interests and others demand for products and services environmentally friendly, winning by feeling a conscious consumer, adding to this perceived benefits the idea of the existence of environmentally friendly companies, which are viewed with sympathy.

Competitive advantage is likely expected to be reached, since firms generate differentiation. The level of service can be enhanced and the company can acquire skills recognized by the market as a positive image in the mind of the consumers.

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