

# A Note on Nano-Photovoltaic Panels Emergence in Energy Market

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**Abstract** - Nanotechnology may work as a powerful weapon to be used for creating competitive advantages in the energy market. Through the use of photovoltaic nano-panels, which may reduce considerably production costs and simultaneously meet socio-environmental requirements demanded by law. It is a way to produce clean energy in innovative terms. Moreover, today the adoption of nanotechnology in energy production can in turn make this kind of energy quite interesting through time. Nanotechnology may be responsible for considerable economic and environmental gains.

**Keywords** - *Nanotechnology, photovoltaic nano-panels, solar energy, process.*

## 1. Introduction

In this new era of global competition, technological innovations are a way for companies to overcome the challenges that are met in this competitive context, by applying innovative processes to their production structures.

Presently, there is a permanent run to technological innovations by companies in the market aiming to get ahead in the competition struggle. This has been happening especially in the last decade in which product life cycle has decreased considerably. Many developments in terms of innovations have been seen in sectors such as, communications, medicine, robotics, computing, energy or in many other areas of society.

It is quite relevant to see the role that the Internet has taken up, as well as the development of mobile devices, new medical imaging, self-service centers, banks, etc. The truth is that people have become dependent on new technologies while companies have become dependent on the process of constant search for innovation. As some people do better professionally than others, some companies also do better in the competitive environment than others. Notably, in both cases, both individuals and

companies that stand out have something in common: the ability to innovate.

In this scenario, this paper aims to highlight one very significant scientific advance in human history - nanotechnology, which opens up unimaginable possibilities in various fields of human reality and in various fields of science. Today the influence of nanotechnology can be seen in areas such as medicine (implantation of nano-robots, for example), agriculture (for pest control) or many others. The possibilities are endless in these fields.

This work shows the use of nanotechnology in industry, discussing how the use of nanopanels may trigger very interesting gains in the industry, by innovating in a topic that allows for long term gains in several domains. The use of nanotechnology in industrial production processes is evidenced in particular in electric energy production by photovoltaic panels. Emphasis is placed on the competitive advantage associated with the use of nanotechnology to solar energy production for companies in this market segment.

The American firm “Nanosolar”, whose studies are sponsored by major companies like Google or IBM, or resulting from the allocation of benefits offered by the Department of Energy, is leading the race on energy production derived from nanotechnology. It has identified this technology as “nano-photovoltaic panels”.

The use of this product has showed a reduction in firms’ total costs in relation to other types of solar energy, and meets government requirements and the importance of social use of energy when it is obtained from clean sources.

Despite the high feasibility for the economy and the environment, there are some considerations regarding the ethical and moral limits on nanotechnology that should be taken into account.

## 2. The Emergence of Nanotechnology

The first person to conceptualize Nanotechnology was Richard P. Feynman, although he had not used this term in his speech to the American Physical Society on December 29, 1959, where he made the first comments on the subject. However, the word “nanotechnology” was first used by Professor Norio Taniguchi (1974) to define the fabrication of a scale of 1 nm. Nanotechnology is the potential ability to create things from the smallest element, using the techniques and tools that are being developed today to place every atom and molecule in place. The use of nanometer implies the existence of a system of molecular engineering, which will likely generate the revolution of the factory-manufacturing model, as it is known.

Nanotechnology will offer, in addition to higher quality products at a lower cost, a range of possibilities to generate new means of production and new types of resources and factors. This is a manufacturing system that could produce more manufacturing systems (plants that produce other plants) in a quick, cheap and clean way. The means of production may be reproduced exponentially. So in just a few weeks, power would pass from a few to several billion nanofactories. Thus represents a kind of revolutionary technology, manufacturing, powerful, but also with many potential risks, besides the existing and well-recognized benefits (see Euroresidentes, 2011, p. 01).

In Brazil, the Ministry of Science and Technology’s budget for the next four years is R680 million. Overall it is estimated that only developed countries are to allocate a sum of around USD 5.5 billion. An important example of successful application of nanotechnology is *Empresa Brasileira de Agropecuária* (Embrapa). It has been working with nanotechnology in various research centers and has already released some products. One of the most notable is perhaps the “electronic tongue”, a device that combines chemical sensors with nanometer-thick with a computer program that detects flavors and aromas and serves to control quality and certification of wines, juices, coffees and other products ( see DIEESE, 2008, p. 03).

There is an interesting reconfiguration of the industrial model, directly related to the use of nanotechnology in the various branches of economic activities. This study gives an outline for the manufacture of electric power, which generically

McKibben considered itself as a country's economy (see McKibben, 2009, p. 24).

Nanotechnology is therefore contributing for the transformation of traditional models, independently of the way goods and services are produced or of the way production is conducted and made.

## 3. Nano-photovoltaic panels as an innovation

Nowadays solar panels are a way to produce energy. There is a well-known level of efficiency and expectations that are got with the traditional panels, which may be compared with new forms of producing energy when using other kind of non-traditional panels.

Considering that, some notes about innovation and new forms of obtaining efficient processes get required. Actually, companies need to be dynamic in the development of innovations and thus creating competitive advantages through its production processes so they can create economic value, and consequently generate their viability based on the market in which they operate. For McDonough III (2009, p. 04) “in the current buoyant economy, 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 in this environment that requires from companies a high degree of competitiveness.

The competition is part of a dynamic and evolutionary operation of the capitalist economy. The evolution of this economy is seen as over time based on an uninterrupted process of introduction and diffusion of innovations in a broad sense, i.e. any changes in the economic space in which these companies operate, whether changes in products, processes, sources of raw materials, forms of productive organization, or in their own markets, including in terms of geography (see Schumpeter, Brazilian version, 1982, p. 65).

According to McAfee and Brynjolfsson (2008, p. 78) “the result is that an innovator with a better way of doing things can grow at unprecedented speeds and dominate the industry”.

In contrast, at the same time, which seeks a high level of competitiveness, it is understood that there is a need for companies to retain the existing common resources for their optimization in the future because

it is not possible no longer count on such a supply of natural resources to meet the continuing huge demand, given the level of production that humanity has achieved over the last century.

To Nogami and Passos (1999, p. 03), the harsh reality of scarcity arises the necessity of choice. Since it is not possible to produce everything that people want, mechanisms must be created to somehow show the societies the path to decide what goods to produce and which needs are met.

The appropriated concepts which are consistent with the possibility of economic efficiency and technological means demand a study that requires an integrated analysis of the proceedings related to the production combination of forces and the structure of supply inside the production unit in order to get efficient processes. All the means or methods of production indicate some of these combinations. Production methods vary in the way how such combinations occur, or by objects or by the combined ratio of their quantities. Every concrete act of production incorporates some combination thereof. It could also be considered as a combination enterprise itself, and even the production conditions of the whole economic system (see on this subject Schumpeter, 1982, p. 16).

The possibility of economic and technological efficiency reflects a producing combination of forces and inputs to reach an interesting production level for the company. All the means or methods of production indicate different sorts of combinations. Production methods vary in the way by which such combinations occur, or by objects or by the combined ratio of their quantities. Every concrete act of production incorporates a kind of combination. A company can itself be considered a combination by itself, and even the production conditions of the whole economic system (see Schumpeter, 1982, p. 16).

Thus, it can be said that any company when producing goods and services through the use of clean energy (in particular, the use of photovoltaic panels produced by nanopanels) generates competitive advantage by breaking the closed circle of the economy. This is made by creating a new mechanism of generation of market value, since it is a new way to produce through a new combination of available resources.

The photovoltaics manufacture with this new technology, the nanopanels, are in fact a great innovation in the production of clean electric energy.

As can be seen in the table below, the production of electric energy with nanopanels is enormously cheaper than with the photovoltaic silicon panels; and reach a price comparable with the one of the traditional power energy, being yet higher. So, the nano photovoltaic panels begin to be competitive with the traditional electricity production means. This considerable power can also be interpreted as the ability to break paradigms in the energy industry, taking the form of a powerful competitive weapon of production units. Given this framework, electric energy production through photovoltaic nanopanels becomes evidently interesting for the production units, whether public or private.

Type of energy	Cost per kWh (€)
Electric power network	0,12
Photovoltaics (Silicon Panel)	3,75
Photovoltaics (nano-Panel)	0,34

Cost per energy type

(Source: Adapted from Scientific American 2008)

#### 4. The Utilization of Nanopanels in the Industry

Considering Chavaglia and Filipe's recent researches for solar panels in Brazilian market, some results are presented in terms of the nanopanels technology and some specific examples for Brazil are shown.

In order to describe the way how a nanopanel is got, it can be said that first it is necessary to produce the semiconductor's nanoparticles (about 20nm in size, equivalent to 200 atoms in diameter). Then, aluminum sheets are placed in press, similar to those used in graphic paper. These aluminum sheets may be very dynamic in their use, because of their length and their width. This makes the product much more adaptable to formats required for the product. Then a thin layer of semiconducting ink is painted on the aluminum substrate. After that, another press put layers of cadmium sulfide and sulfur, and zinc oxide (CdS and ZnO). The layer of zinc oxide is non-reflective to ensure that sunlight is able to reach the semiconductor layer. Finally, the sheet is defined in sheets of solar cells. Unlike other methods of panels manufacture that are usually used, which typically requires a special location for manufacturing, nano-

panels can be produced outdoors (Chavaglia et al, 2012).

This technology is very interesting, reaching good results either in terms of costs when compared with other solar panels and has also improved significantly when compared with the performance of public energy. These costs have coming to be considerably reduced.

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 this country for a long period. 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, when compared with solar photovoltaic panels (silicon). Nano-panels permit also to perceive a competitive advantage in environmental conservation terms, if compared with the energy provided by public network (see Chavaglia et al, 2012).

Therefore nanotechnology is contributing for the transformation of traditional models. This transformation may be in the way goods and services are produced, or in the way the production is conducted and made.

## 5. Final Remarks

The possibilities open to mankind through nanotechnology are enormous. It encompasses the way people connect with each other and with the natural resources for the production of goods and services.

First, it is prudent to recognize that there are dangers when using nanotechnology. These dangers may get materialized under the prism of problems arising from human nature itself, as corruption and bad faith, or the overexploitation of resources.

However, the advantages arising from the use of nanotechnology may mean breaking with paradigms in what concerns to the attendance of the consumption needs of humanity. These advantages may be visible in particular in terms of reducing costs

and increasing the quality of both the products and the production method, and can be seen in the case of electrical energy production based on nano-photovoltaic panels.

Therefore it is necessary to be precautionous when using nanotechnology. It is important to stress that the benefits can be got not only for the production units as well as for society in a whole. Its use allows mankind to gain additional levels of wealth and quality of life. Anyway, the balance between costs and benefits must be taken into consideration in the analysis of all the relevant elements.

The experience shows that nano-photovoltaic panels may bring interesting results for economies and bring a new form of producing energy with considerable advantages in the long term.

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