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The Waste-to-Energy Business Model in Mexico: A Study of Three Companies in the Country

EL MODELO DE NEGOCIOS WASTE-TO-ENERGY EN MÉXICO: UN ESTUDIO DE TRES EMPRESAS EN EL PAÍS

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Abstract: ***The main objective of this research is to identify the main aspects presented in three companies of energy generation from biogas produced by landfills in three cities of the country: "BENLESA" in Salinas Victoria, Nuevo León; "YLEM ENERGY LIMITED" in Aguascalientes, Aguascalientes; And "Biogas Juárez" in Ciudad Juárez, Chihuahua. Analyzing these companies, their way of operating and business environment identifies the existence of business opportunities in this area. It is concluded that there is a great potential of wasted business that works through market mechanisms in strategic alliance with public entities as a more viable option for the reduction of investment risk and the viability of the projects. The use of high technologies, composition of city waste and available infrastructure are key factors.***

Keywords: Biogas, Business of bioenergy, Landfills, Waste-to-energy

JEL: Q4, Q53, M2

Resumen

El objetivo principal de esta investigación es el identificar los principales aspectos presentados en tres empresas de generación de energía a partir del biogás producido por rellenos sanitarios en tres ciudades del país: "BENLESA" en Salinas Victoria, Nuevo León; "YLEM ENERGY LIMITED" en la Aguascalientes, Aguascalientes; y "Biogás Juárez" en Ciudad Juárez, Chihuahua. Analizando dichas empresas, su modo de operar y entorno de negocios se identifica la existencia de oportunidades de negocio en este ámbito. Se concluye que existe un gran potencial de negocios desaprovechado que funciona mediante mecanismos de mercado en alianza estratégica con entidades públicas como opción más viable para la reducción del riesgo de las inversiones y la viabilidad de los proyectos. El uso de tecnologías de última generación, composición de los desechos de la ciudad e infraestructura disponible son factores clave.

Palabras clave: Biogás, Empresas de bioenergía, Relleno Sanitario, Waste-to-energy

1. INTRODUCTION

The world moves with energy; transport, companies and people demand energy at all times to carry out their common activities. Society consumes energy at accelerated rates, which mostly comes from fossil fuels, mainly hydrocarbons, such is the vertiginous consumption of hydrocarbons that for decades has been concerned about the underlying effects it causes. The environmental impact caused by the combustion of hydrocarbons and its characteristic feature of being a nonrenewable resource gave a sound of alarm in diverse scientific, civic and political groups arising a great interest by the renewable energy sources. Solar, wind, geothermal and bioenergy are some of the main sources of non-renewable energy.

As Mexico is a country with a large population and abundant natural resources, the use of renewable energy has had importance at different levels and a legal framework has been sought for the emergence of companies that are dedicated to the production of energy with renewable sources. Fortunately, the use of biomass to generate energy is promising enough to pay attention to the various uses that can be given to waste. It is said that each person produces one kilo of solid urban waste (MSW) a day. Three companies are already taking advantage of this business opportunity. This research focus on electric power generation plants from urban solid waste as profitable businesses in the country. For it there are being studied three companies of this turn that are operating in the country, identifying their strategies it can be stipulated a serial of key factors for the opening and successful operability of this type of business in Mexico.

2. BACKGROUND OF THE PROBLEM

The supply of energy has been a problem that has preoccupied several interest groups for several decades, not only if the

supply can satisfy the demand but also the harmful impact of its production and use on the environment through Greenhouse gases (GHG). The enormous level of consumption of hydrocarbons in the world has led to the change of paradigms to obtain the energy necessary for the operation of the economy. According to data from the World Bank (2017), in 2014 81% of the total energy consumed in the world came from hydrocarbons while alternative energy has a share of around 10% globally.

The alternative energies are all those that are not based on the combustion of the hydrocarbons and, in general, they are renewable energy sources. Examples of renewable energies are wind energy, solar energy, geothermal energy, bioenergy or tidal energy. According to Masera, Coralli, García, Riegelhaupt, Arias, Vega, Díaz, Guerrero and Cecotti (2011), bioenergy, which is the energy that can be obtained from biomass, represents 77% of total renewable energy, estimating that by 2035 this type of energy source would represent 25% of the total energy required by the world.

According to Cerdá, Caparrós and Ovando (2008), renewable energy can be used for electricity generation, thermal use and biofuel production; However, only bioenergy is capable of being used for all three things, unlike wind and solar energy that cannot be converted into biofuel. Biomass, for its part, is a constituent part of living beings, can be divided according to its source (Monreal, 2008):

A. Food source: It comes from grains or other crops, it is also used for human and animal consumption.

B. Non-food source: It comes from residues such as manure, crop and forest residues, food waste and municipal solid waste.

A shift from hydrocarbon-based to biomass-based economy would represent a significant shift in technical and socioeconomic systems (McCormick & Kauto, 2013). Although its large-scale production is possible, its effects on food security have not been satisfactorily weighed (Reilly, 2015).Thus, biomass from food sources is often limited in many crops such as maize and beet (Becerra, 2014). This is due to the food deficit that exists in the country, especially in maize.

Therefore, biomass from non-food sources is often seen as a better alternative. There is a significant trend towards the use of various wastes for energy production, which led many investors to pay attention to electric power generation plants based on urban solid waste, millionaire's businesses that are evaluated here.

3. JUSTIFICATION

This work was born to generate a rapprochement with the companies that have succeeded in turning power plants based on urban solid waste in Mexico. In particular, it is studied the factors and strategies that led three companies of the same sector to their operation and staying in the energy market. The study of three companies in operation allows the identification of factors that can be used for the stipulation of general factors that can help in the implementation of more companies of energy generation based on urban solid waste in more areas of the country that result successful and profitable for both private capital and social interest.

4. THEORETICAL-CONCEPTUAL REVIEW

Bioenergy is the energy that is obtained from biomass. It can be found in a variety of forms. Biomass is the constitutive material of living beings, excreta or non-living remains (Masera et al, 2011). Salinas and Gasca (2009) extend the definition of biomass referring to that can be any type of organic matter that has had its immediate origin in some biological process of organisms recently alive, classified even as follows:

a) Primary biomass: vegetal biomass, agricultural and forest residues.

b) Secondary biomass: manure and meat of herbivorous animals.

c) Tertiary biomass: remains and ejection of carnivorous animals.

d) Natural biomass: produced in wild ecosystems.

e) Residual biomass: extractable from agricultural, forestry and human activities.

f) Energy crops: any agricultural crop whose purpose is the supply of biomass for the production of biofuels.

At the international level, 85% of the energy generated by biomass is considered as "traditional use", i.e. use of firewood or manure at domestic levels; The other 15% is of industrial use for the creation of fuels, heat and energy processes, and electricity (Donald, 2007).

One of the many products that are the result of the processing of biomass are biofuels, defined as all those biofuels such as alcohols and other chemicals that come mainly from biomass that can substitute to some extent the use of gasoline in transport or destined producing electricity (Salinas and Gasca, 2009). On the other hand, Masera et al (2011) made a classification of biofuels according to their origin:

a) Wood fuels from natural forests and plantations

b) By-products of logging and the timber industry

c) Agricultural byproducts

d) Livestock byproducts

e) Agro-industrial byproducts

f) Energy crops

g) By-products of municipal origin

However, for the purposes proposed in this work, attention is being devoted to everything related to by-products of municipal origin or also called solid urban waste (MSW). A solid residue is nothing more than any product, matter or substance from human activity, which can have different origins (households, industries, etc.) and diverse composition (paper, glass, plastic, etc.). The product of greatest interest in urban solid waste processing is biogas, a gaseous fuel generated by biodegradation reactions of organic matter in the absence of oxygen. The produced methane can easily be converted into electricity for use in homes or industries.

One of the most appropriate methods for the generation of methane from municipal waste is anaerobic digestion (Nasir, Ghazi and Omar, 2012). For Ferrer and Pérez (2010) this process generates hydrogen sulphide and carbon dioxide in large quantities which represents a lower yield of methane quality. Even so, anaerobic digestion is still the most viable method with the current technology, because it represents a relatively lower cost and less production of waste arising from the production process, making this method one of the most used in the world (Morita and Sasaki, 2012).

Opportunities in this sector have been exploited by governments and companies in several countries around the world, especially in Europe (Cerdá, Caparrós and Osvando, 2008). In Mexico, this potential has not been properly exploited, and three companies that have been successful in this industry are analyzed: Benlesa in Salinas Victoria, Nuevo León; Ylem Energy Limited in Aguascalientes, Aguascalientes; And Biogas Juárez in Ciudad Juárez, Chihuahua.

For the analysis of these three companies three perspectives are used that are considered strategic in the companies (Peng, 2012). First, an analysis of the industry in which these companies compete; Second, an analysis based on resources and, thirdly, an analysis from an institutionalist approach. The industry analysis corresponds to a review of the five operating forces in the well-known Porter Diamond, which emphasizes the state of five determinants in a specific industry (Porter, 1991):

1) Degree of rivalry between competitors: a high degree of rivalry implies a more intense competition among companies in the sector.
2) Threat of substitute products: The ease with which a product can have substitutes poses a threat to industry companies.
3) Bargaining power of buyers: the degree of negotiation that consumers have of the product in question will determine the production strategies of a company.
4) Threat of entry of competitors: each industry presents barriers of entry that depending on its intensity will determine the possible entry of more companies to the industry.
5) Bargaining power of suppliers: A high degree of bargaining power of suppliers can bring great administrative problems to companies, being ideal a great variety of suppliers available.

From the second perspective, the resource-based view, it takes as reference the VRIO model designed by Barney and Griffin (1992). VRIO is an acronym for the words valuable, rarity (Barroso and Griffin (1992), emphasizing the heterogeneity of the resources of a company, inimitable and organization:

a) Valuable: resources that have or generate value for the company and the consumer.
b) Rarity: the rarity of the resource in question makes it valuable and attractive.
c) Inimitable: resources that are harder to imitate by competitors give important intangible assets to the company.
d) Organization: it is the way in which the resources are organized and how the organization aligns itself with others.

On the other hand, the analysis is done from the institutionalist perspective, i.e. all norms and rules governing human and social action, conditioning and directing any relationship that arises in it, as they say, represent the "rules of the game" (North, 1990). North (1990) distinguishes institutions in two types: formal institutions, which include laws, rules and / or regulations imposed by government entities or with formal recognition by all members of society; And informal institutions whose main characteristic is to take into account the culture, traditions and beliefs of a given society.

5. REVIEW OF THE EMPIRICAL LITERATURE

For the empirical review, biomass processing plants of different types and in different countries or geographic areas are considered, increasingly delimiting to projects in Mexico based on solid urban waste. In the case of Europe, it has a big boost to biofuels. McCormick and Kautto (2013) note the increase in research and development projects, especially in projects focused on biofuels and bio refineries in countries like Germany. Cerdá, Caparrós and Ovando (2008) analyze that since 1990 the European Union has launched a plan for the development of renewable energy to reduce climate change. They found that the development of bioenergy companies in the European Union depends to a large extent on the existence of policies that encourage such companies and at the same time avoid a negative impact on biodiversity and food prices.

Reilly (2015) uses data from the Food and Agriculture Organization of the United Nations (FAO) to make future projections on the impact of biofuel production on food prices, concluding that there will be no significant impact as long as foreseen the growth policy of this industry. On the other hand; Razo et al (2007) argue that the best market for liquid biofuels is transportation, however, the cost of waste collection and transportation is high with current technology, especially in Latin American countries.

Many authors see forest biomass as a great business opportunity, such as Favero and Mendelsohn (2014) who argue that the production of energy from wood is cost-efficient as long as adequate incentives exist of the government. Sims (2006) places an emphasis on the process of collecting and transporting the plant in the cheapest way possible subject to the availability of fuels and high capital costs. Virani (2011) adds to this the relative price of fuels in use at that time.

There are also a large number of authors who have focused on biofuels from food sources, such as Becerra (2014) who performed simulation routines in different scenarios concluded that ethanol production was feasible in Mexico but only if it is manufactured to from sweet sorghum and sugar cane. Another of its conclusions was the crucial role of institutions to create certainty in the sector in the long term. Massieu and Acuña (2015) add that a Law for the Promotion and Development of Biofuels exists in Mexico since 2008, however, although the sector is incipient, it has already presented problems of socio-environmental violence since some projects have already attacked peasant and indigenous peoples.

In the area of energy production based on municipal waste, Brown and Mann (2008) see great potential in companies with systems that combine heat and power (CHP) differentiating a rural market that has abundance of biomass and ease of implementation of small processing plants, and a municipal market that benefits from waste management systems and infrastructure to collect and distribute energy economically. Williams (2011) makes a study on the effectiveness of the "Waste-to-energy" model in Sweden compared to the companies of this type in the United States, concluding that a legal framework that provides certainty in conjunction with fiscal incentives policies were the key factors for the success of these companies in Sweden.

For their part; Rafati, Rahmani Boldaji, Khodadadi et al. (2016) indicate that in order to apply a certain technology for the conversion of urban waste to energy, must be taken into account the composition of municipal solid waste, the already functional technologies and the waste management strategies that has the city. Bustos (2009) sees a problem of waste collection and recycling in developing countries in which it suggests the need for the involvement of companies and productive associations. Similarly, Medina (2010) notes the potential for the formation of public-private partnerships among cooperatives of collectors, companies and public institutions that can treat waste at low cost. Bernache (2003) identifies the lack of an efficient system of municipal waste management in Mexican cities due to a low interest on the part of the authorities.

6. CONTEXTUAL FRAMEWORK

The development of the section of the contextual framework is divided into three subsections, one for each power generation company based on municipal solid waste: Benley, Ylem Energy Limited and Biogás Juárez.

A. Bio energy of Nuevo León, S.A. de C. V. (BENLESA)

BENLESA is a private public association (APP) that emerged from a strategic alliance between the private company Bioeléctrica de Monterrey, SA de CV, a company that is a subsidiary of Sistemas de Energía Internacional, SA de CV (SEISA) and the Government of the State of Nuevo León through the System for Ecological Management and Waste Processing (SIMEPRODE).It is responsible for the operation of the electric power generation plant based on the biogas produced by the Salinas Victoria landfill, Nuevo León. It provides electricity to the 13 associated entities through a cogeneration permit by the Energy Regulatory Commission (CRE). It is recognized as the first project in Latin America to use this type of technology (Pino, 2013).

This project was sponsored by the Global Environment Facility (GEF) and the World Bank. This was due to the large amount of waste that caused pollution and public health problems. SIMEPRODE started a bidding process in 2001 in which 13 companies competed. Grupo Gentor was founded together with the foundation of Grupo Monterrey. In 1992, in its energy division, Sistemas de Energía Internacional SA de CV (SEISA) and American Gentor Corporation (AGC) were created. The combination of both constitutes Bioeléctrica SA de CV contributing 53% of the initial capital (Pino, 2013).

It was agreed that while Bioeléctrica S.A. de C. V. would be in charge of technical aspects of the project as the operation and maintenance of the biogas plant, SIMEPRODE is the owner of the site of the landfill where the plant is located. The plant was inaugurated in 2013 with a capacity of 7.42 MW, with a private investment of 5.7 million dollars and a support of 5.1 million dollars by the World Bank. After another investment, its installed capacity increased to produce 17 nominal MW and 16 MW net, over the years the plant would obtain the ISO 9001 certificate as a quality management company (SEISA, 2017).

According to Pino (2013), from its opening until 2013, the company has avoided some 800 thousand tons of carbon dioxide and generated a total of 202 thousand 500 MW of electricity, which are used for lighting municipalities in the

metropolitan area, State Government Buildings, Water and Drainage Services of Monterrey, Paseo Santa Lucía, the public transport system and other government buildings. According to the CFE (2012) through the Institute of Electrical Research (IIE), the main benefit for the dependencies that use this energy is a saving of 10% in their electric billing.

B. Ylem Energy Limited

The project was created in the beginning to replace the waste dump of Cumbres by a sanitary landfill that complies with the current regulation of waste management. That landfill began to operate in the municipality of San Nicolás, Aguascalientes in 1998.During the first years in operation of the sanitary landfill of San Nicolás was registered the project of a plant of generation of biogas before the Mechanism of Clean Development (MDL), which arose with the signature of protocol Kyoto in 1997. Then the first approaches arose of the companies Biogas Technology and ENER-G Natural Power (now called YLEM ENERGY LIMITED) presenting projects in two stages: the first would consist of the method to decompose the CH4 molecule and obtain benefits through the sale of carbon bonds; The second stage would consist of electricity generation (CFE, 2012).

The agreement reached was that the municipality would be the owner of all the land, would be in charge of the works of closing the cells, handle leachate, provide coverage and daily maintenance. In turn the municipality of Aguascalientes would receive royalties from utilities obtained both from the sale of carbon credits and from the generation of energy. On the other hand, the companies Biogas Technology and the then, ENER-G Natural Power contributed 100% of the investment capital with a 20-year contract for the operation, maintenance, electricity production and gas rights.

In 2012, the electric power generating plant with an installed capacity of 2.7 MW came on stream. That same year a contract was signed between the Japanese automobile company Nissan and the City of Aguascalientes and the operating company YLEM ENERGY LIMITED in which Nissan acquired 100% of the electric energy generated by the waste processing plant, a contract that to date is still standing.

To date, this project is not only generating benefits for private companies, it also causes savings in the electric bill of its users at a very low environmental cost, obtaining until 2012 profits of 1.7 million dollars (CFE, 2012).

C. .Biogas of Juárez S. of C. V.

The sanitary landfill of Ciudad Juárez, Chihuahua was opened in 1994 which has a capacity of more than 10 million tons of urban solid waste. Biogas of Juarez S. of C. V. is a company whose capital is totally Mexican, specialized in the extraction, burning and use of biogas generated in the sanitary landfill of Ciudad Juárez.The project was carried out jointly with the Federal Electricity Commission, registering to the CDM and generating carbon credits that same year. The operations began in 2011 with a capacity of 4.5 MW, where its clients are mainly the self-sufficiency and the municipal public lighting of Ciudad Juárez and Nuevo Casas Grandes, both in the state of Chihuahua. This capacity makes it the second largest electric power plant based on municipal waste in the country, only after BENLESA in Nuevo Leon.

7. METHODS OF RESEARCH

In this research a qualitative method is presented based on the review of the existing literature in different countries, as well as the histories of the three companies mentioned in the previous section from the perspectives proposed in the tripod of Peng's strategy (2012) In order to explain and describe more fully this type of business.

8. RESULTS

It is analyzed the three companies mentioned above, taking into account the tripod of Peng's strategy (2012), so that there are three perspectives that help to see the fundamental aspects of electricity generating plants based on municipal waste.

A. Results from an industry-based view

To analyze the point of view based on the industry, the Porter diamond is used as a guide:

1) Degree of rivalry between competitors: from the three cases analyzed it is possible to notice that the industry mentioned in this research has a very low level of competition, where companies have a legal monopoly by being allied with public institutions of the municipalities where they are, therefore it is a market with low level of rivalry.

2) Threat of substitute products: this type of energy production is put aside from other sources of renewable energy or biomass, sometimes unfairly competing with each other.

Although in theory the different sources of renewable energy are substitutes for hydrocarbons and not substitutes for each other, in practice it is usually chosen from one type to another. It is because of this variety of energy production techniques that electric plants based on municipal waste have substitutes, however, other substitutes would not successfully end up with the problem of overproduction of garbage in the cities, so the existing potential in landfills would remain attractive.

3) Buyer negotiation power: One of the great advantages of the three companies reviewed is that, as part of municipal and state projects through public private partnerships, the partner on the public sector side is

usually the client, giving an enormous certainty to the business and reducing the risks that the investment entails when taking joint risks and long-term contracts. In the case of Ylem Energy Limited, the client is a large automotive company that has been committed through a long-term contract, this is also a mechanism to reduce the risk of investments.

4) Threat of entry of competitors: within the industry the threat of entry is practically null at the moment, this is because the operating companies won a bid and form a partnership between public and private capital that allows them to have management costs and disposal of very low resources that a privately owned company could never achieve.

5) Bargaining power of suppliers: the review allows to say that much of the technology used in the plants is imported or, as in the case of Biogás de Juárez, there is an alliance with a foreign company that has the patent of the technology. However, all the necessary technology is easily adaptable in Mexico.

The waste disposal is not a problem in this industry since the integration of the private sector with the public sector has internalized the collection and disposal of waste without extra costs, thus ensuring the constant flow of waste to be treated.

B. Results from a resource-based view

This analysis takes as reference the VRIO model detailed in the conceptual section of this document.

1) Valuable: As stated earlier, generators used by these types of companies are easily adaptable by any company that wants to compete in this sector. The truly valuable aspects of the companies focused on the transformation of biogas into electrical energy correspond precisely to the association between the know-how belonging to private companies and the infrastructure and systems of collection and separation with which the government has.

2) Rare: Public and private partnership is a rare resource because interested companies must compete in a public tender in which they must submit a technical proposal and an economic proposal that corresponds to the interests of the project. One of the interesting aspects is the type of customers this entails, since usually the customer is the same public sector or a large company (Nissan case in Aguascalientes), the electric power needs of these entities are usually high and constant. Being the supplier of these entities represents a rare and economically attractive intangible asset for energy companies.

3) Inimitable: the business model presented here is and should be inimitable in any other region that meets the necessary characteristics such as a composition of urban waste that facilitates the process, adequate facilities in landfills and adequate mechanisms of collection and separation of garbage.

4) Organization: the effect is greater when it is a large company that makes the investment. In the case of Bioeléctrica de Monterrey SA de CV has a company with great financial capacity and experience in other parts of Mexico, that together with the existence of a sanitary landfill certified in the municipality where it operates and with it an efficient collection and separation of waste, the companies of this sector have a good organization that is certified before the CDM as friendly companies with the environment and ISO-9001 that certifies them as quality management companies.

B. Results from Institution-based Vision

The role of formal institutions in the companies studied is preponderant since, to begin with, the project would hardly have started without some incentive by a global institution such as the World Bank or the signing of the Kyoto Protocol. Based on this incentive, the public institution prepares for a project for the use of municipal waste to generate electricity and launches a public call. Several companies that prepare their proposals respond to this call. The government entity chooses the winner of the tender and a contract is made.

In all the cases studied, the result is the creation of an association composed of private capital and public capital, the latter always in charge of facilitating the existing infrastructure and collection mechanisms, reducing operating costs and facilitating the operation. All the companies studied have negotiated with carbon credits and have benefited from monetary support from institutions that support environmental projects. It is because of this that the role of formal institutions in this type of business is crucial for economic and operational viability. On the other hand, the role of informal institutions, that is, the cultural component of society, is less preponderant than that of formal institutions, but its importance lies in the consumption and recycling habits of a society.

An important point for the optimal processing of urban waste is its composition, the food habits of the inhabitants will determine the type of waste that will have and thus the type of management that they should have. Another important point is the culture of recycling a society, the transformation of municipal waste is not opposed to recycling, on the contrary, helps the separation and efficient use of waste.

9. CONCLUSIONS AND RECOMMENDATIONS

One of the most important conclusions of this research is the importance of public sector involvement in this type of business and is that, by itself, the transformation of waste into electrical energy that can be a business with a high degree of

risk that begins to generate long-term gains. For this reason, a public-private partnership has been the most successful mechanism. State involvement allows to generate certainty and to provide free of charge waste and existing infrastructure.

Companies that want to enter need to adapt existing technology, as a state-of-the-art technology will improve waste performance making them cost-efficient. Companies have the option of partnering with other energy companies that have technology patents to be more efficient.

There are very few companies that use waste to transform it into electrical energy, which represents a great business opportunity because it is an unsaturated market in which intangible assets can be very valuable. Of course, public institutions must first work on maintaining adequate sanitary landfills for waste management and, secondly, the initiative to carry out projects and approaches in these areas.

In this way, it is concluded that there is a wasted opportunity that can generate profits for private companies, savings and profits for government institutions and an environmentally friendly solution to deal with the problem of municipal waste abundance.

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