

# ANALYSIS OF ELECTRICAL ENERGY COGENERATION BY SUGAR-ALCOHOL SECTOR IN STATE OF SAO PAULO.

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**Summary** – On 2001, Brazil went through an unprecedentedly crisis of energy supply it coincided with restructuration of brazilian electrical sector, that allowed energy own-producers, such as sugar-alcohol sector to commercialize the excess obtained from cogeneration process, that on spite of high potential commercialization it is not being appropriately used. This work characterized cogenerated energy market and analyze the problems in cogenerated energy commercialization, considering transactional and economical costs by sugar-alcohol sector and distributing energy industries. For information collection semi-structured interviews were carried out involving the responsible by the cogeneration area of mills and the distributing energy industries. These interviews consisted of predetermined questions that were applied in the manner and sequence for all those interviewed to assure comparison of results. The interviews were recorded, transcribed and analyzed through the content analysis. The results indicated that long-term business contract could be established, but transactional and economical costs between dealers can overcome the benefits of cogenerated electrical energy commercialization leading the dealers to act preferentialley on spot market.

**Keywords:** transaction and economic costs, cogeneration, trade.

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## 1. Introduction

In 2001, there was an unprecedentedly crisis of electrical energy shortage in Brazil, and the government implemented energy rationing in several areas. Such kind of crisis may lead the country to adopt other electrical energy generation alternatives, such as electrical energy co-generation<sup>1</sup> from sugar cane bagasse that, for several years, has been adopted by sugar cane industries aiming at the own supply of electrical energy and, more recently, some of them have been commercializing the surplus with distributors.

According to Sleiman (1999), electrical energy co-generation surplus has a strategic position related to the valorization of regional economical activity, environmental matter, more efficient use of energy resources and competitiveness of the industrial sector. According to Coelho & Zylbersztajn (1998), the sugar cane sector can take advantages from energy surplus sale due to economic difficulties of sugar and alcohol sale prices in the world market that, according to Delgado (2000), have not covered production costs, causing the need of aim economies diversification and implantation.

The commercialization of electrical energy co-generated by the sugar cane sector became possible with the Brazilian electrical sector reform that allows the government to be centered in elaborating policies of energy and the sector regulation, transferring to the private sector the responsibility of operations and new investments. Thus, it is possible that co-generation has a greater participation in the Brazilian energy matrix due to its importance as an alternative energy source in periods of energy offer reduction.

The consequence of the electrical sector reorganization for sugar cane sector is the perspective of a new business with the sale of energy surplus firstly to concessionaires then, in the near future, to free consumers. The sector reorganization and privatization of energy distributing and generating companies are favorable to electrical energy market competition.

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<sup>1</sup> Co-generation refers to any form of simultaneous production of thermal and electrical energy for self-consumption or sale.

Despite the advantages of co-generation, sugar cane bagasse surplus has not have an economically possible use either in electrical energy generation or other applications. In some cases, this excess has been used as volume of animal ration, fuel in orange juice industries or even in small surplus generation of electrical energy sold to concessionaires by reduced prices (DNA Canade-Açúcar, 1998).

Most papers analyze the potential advantages of co-generation, but a few papers analyze more consistently the obstacles to co-generated electrical energy commercialization like those by Baptista (1998), Curi (1997) and Coelho e Zylbersztajn (1998), who worked on the sector regulation matters.

The hypothesis subjacent to this work is that there are trade and economical costs surpassing the commercialization benefits of energy co-generated by the mills, and because of this the potential has not been used.

This work aimed the characterization, of the co-generated electrical energy market as well to analyze the obstacles of the sugar alcohol sector and distributors in commercializing the co-generated energy due to the existence of trade and economical costs.

## **2. Methodology**

### **2.1. Data collect**

Commercialization costs are hardly measurable by the quantitative point of view, however it is possible to understand the view of economical agents involved through the analysis of the parameters that rule energy purchase and sale agreements and the transactional obstacles that become difficult this market performance.

In the present study, it was used the semi-structured interview formed by standardized open questions, following a basic route whose items were previously obtained, with answers under the interviewed person's criteria. The advantage of this kind of questionnaire is to allow the interviewed person to show his opinion, points

of view and arguments, being well directed by the interviewer so that all the items can be fulfilled.

Interview is the most used technique in social inquiries, being possible to be used as the main technique of a study or combined with others and also be done through personally contact or by telephone (Alencar, 1999). To carry out the interview, it is used a form and/or a schedule. Such instruments are planned and elaborated considering the problem, the study objective, its theoretical reference and hypothesis, and it provides information related to a search object and insertion of themes also related.

Perosa (1999) presented an example of semi-structured interview used as a method of data collect, where the author evaluated the perception of agents of cow meat agrofeeding system segments about the coordination role in this system competitiveness, aiming at trade costs reduction. According to the author, the agents' opinions are subjective and this kind of qualitative information collect shows the interviewed person's vision.

Two types of data can be obtained: those that refer to facts that the interviewer could get from other sources, such as census and statistics, and the data which refer directly to the person interviewed, that is, his attitudes, values and opinions (Minayo, 1998).

The fundamental questions that make up the semi-structured interview are a result not only of the interviewer's theory but also of all information about the social phenomenon of interest (Triviños, 1987).

To prepare the interview schedule, contacts were made with the technicians of Coopersucar, in Piracicaba city, Associação dos Fornecedores de Cana-de-açúcar (Association of Sugar cane Suppliers) in Lençóis Paulista city, and the sugar cane mills São Manuel, in São Manuel city and Barra Grande, in Lençóis city. The main sugar cane mills of Bauru/Botucatu region and one from Ribeirão Preto region were selected. Since the sector regulation covers the whole sector, it was assumed that the trade costs raised in this sample should represent the perception of the sector as a whole. These contacts had the objective to collect information about the trade of energy co-gen-

erated by the sugar alcohol sector. From the data, it was prepared a form directed to co-generated electrical energy market characterization and to the obstacles for this energy trade.

The interviews had two main focuses defined during previous contact with the area technicians: a) characterize the co-generated energy market using sugar cane bagasse from 4 main basic characteristics: transactions frequency, uncertainty, informational structure and assets specificity; and b) analyze the ex-ante and ex-post transaction costs which were an obstacle to co-generated electrical energy market expansion.

Although the situation in terms of commercialized co-generated energy volume was different among the mills, the same questionnaire was used, once it was expected that the mills which was not commercializing energy yet highlighted more the ex-ante costs and those which already commercialized some volume of energy would favored the ex-post costs in the answers. The chart below presents information on the analyzed mills:

Table 1 – Information about the five analyzed mills, 2001

Mills	Location	Commercialize	Beginning	Quantity(MW)
São Manoel	São Manuel	No	-	-
Barra Grande	Lençóis Paulista	Yes	1999	13,8
São José	Macatuba	Yes	2001	8,0
Usina da Barra	Barra Bonita	No	-	-
São Martinho	Pradópolis	Yes	1987	4,0

Source: data obtained from the mills by the authors

The ex-ante costs were referred to information search and acquisition, consultancy and agreement elaboration while the ex-post costs were guaranties, insurances, monitoring and juridical attendance, renegotiation and maintenance.

To assure better results, during the qualitative data colet in the sugar cane mills and electrical energy distributing companies, it was favored those interlocutors who, due to their positions and/or their

knowledge, were able to present a wide view about the situation of electrical energy co-generated by sugar cane sector, the trade evolution and difficulties, as well each agent's expectation with relation to the proposed question.

People who were interviewed were those in charge of the co-generation sector of São Manoel, Barra Grande, São José, São Martinho, Usina da Barra mills, all of them in São Paulo state, and Companhia Paulista de Força (CPFL) whose home office is in Campinas city – SP.

The semi-structured interview is formed by pre-determined questions read precisely in the same order and manner to all people interviewed to assure the results comparability. They were recorded from April 19 and May 4, 2001 and lasted about two hours each.

## **2.2.Data treatment and analysis**

The methodological process followed two basic plans: a) data collect – the interview itself, using open questions with the objective of observing the interviewed person's perception about the mills situation as for the trade of electrical energy co-generated by this sector, trade evolution and the sector difficulties in commercializing it; and b) data tabulation – qualified and attentive reading of each interview, standing out contents and themes previously defined as important, organized in tabulation schedule.

Interview procedures linked data collect and tabulation to the pre-determined and coherent questions, avoiding large amount of data and information disconnected from the survey purposes. The interviews were recorded, written and examined, and the answers were grouped according to the questions.

In this study, it was used the content analysis technique proposed by Triviños (1987) which is formed by three stages: pre-analysis, analytical description and inferential interpretation. Pre-analysis is simply the material organization. Formulated the hypothesis about determined theoretical support, with the techniques used for information gathering, there is material to be studied through the content analysis.

Analytical description begins during the pre-analysis when the material collected is submitted to a study guided by the hypothesis and theoretical references, where the agents' answers were submitted to a deep study.

The referential interpretation phase, supported by information material, which began during the pre-analysis phase, has now its greatest intensity. Reflection and insight based on collected material establish relations about the difficulties of co-generated electrical energy commercialization.

The third phase of the content analysis method allowed us to establish several relations among questions raised by the agents and the difficulties in co-generated energy trade. Figure 1 shows the sequence of all phases developed.

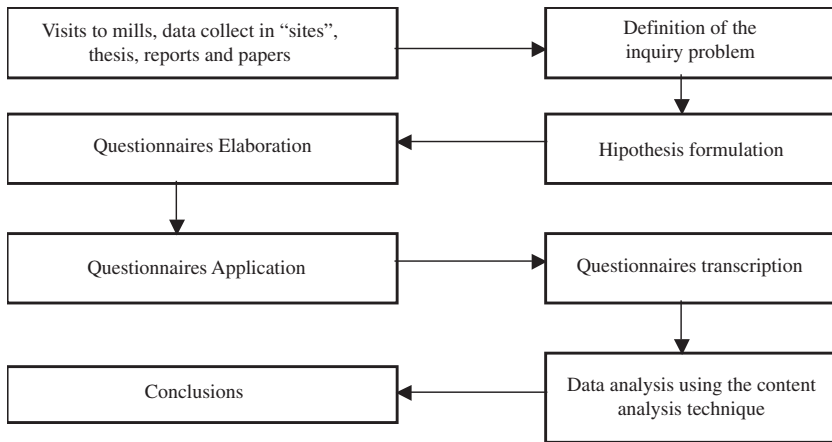


Figure 1 – Sequence of the phases developed for this inquiry.

### 3.Results and discussion

The results were divided into two parts: In the first one, this market characteristics are described according to the information obtained from the agents about transactions frequency, uncertainty, information structure and assets specificity. In the second phase, it was evaluated the main parameters of the agreements generating transaction and/or economical costs to the agents.

### 3.1 Co-generated electrical energy market characterization

The electricity generation technical potential calculated for sugar alcohol sector reaches 3,852 MW, however the effective availability or energy surplus by the mills in 2001 is still at very low levels. Until September 2001, 132 MW were available by 28 mills in Brazil, corresponding to 11% of these mills technical potential, and only 3,4% of the total technical potential for the country. In São Paulo state, the energy co-generated by sugar cane sector corresponds to less than 1% of the consumption.

The energy surplus co-generated by the sugar cane sector is commercialized in spot<sup>2</sup> market and in short term, although some characteristics of this market should lead, naturally, to long term agreements, such as high transactions frequency, high uncertainty, incomplete information structure and high assets specificity, as described following.

#### 3.1.1 Transactions frequency

The frequency is associated with the periodicity in which the transactions occur. Some of them occur in an unique point in time while others are recurrent. The transaction cost related to a unique transaction is not enough so that a structure of this transaction control is established, in a way that the purchase and sale operations are normally done in the spot market.

When the transactions are recurrent, it is economically viable the construction of a control mechanism. A long term agreement relatively to a spot market agreement, presents economies as the number of transactions increases. The costs of agreement writing, relevant information collect, monitoring, and adaptation to environment changes dilute as the transaction frequency increases. The co-generated energy market can be considered, presently, as a market of high transactions frequency, because, although the commercialization occurs only during the round-up time (May to November), the supplying is daily.

<sup>2</sup> The mills which commercialized energy surplus did it at MAE (Mercado Atacadista de Energia) (Energy Wholesale Market), which was replaced by BEM (Mercado Brasileiro de Energia) (Brazilian Energy Market), in January 2002, both considered as spot markets.



### **3.1.2 Uncertainty**

According to Knight, cited by Zylbersztajn (2000), uncertainty is associated with non-foreseeable effects, once it does not have a known probability function associated with them. According to Farina (2000), the greater the uncertainty, the greater the future contingency and so, more complex the agreement elaboration is.

The Brazilian electrical energy market has been in a deep reorganization, with the government concentrating in functions of energy policies elaboration and the sector regulation. With the sector restructuration, energy commercialization rules are in phase of elaboration, adaptation and approval, which has generated uncertainty among the agents, such as:

- a) uncertainty as for the market – it refers to the payment of energy purchase and sale agreements, for the criteria of energy values updating have been negotiated. MAE offered better payment than the agreements with distributors, but it was extinguished in January 2002 because it did not work adequately, and became a conflicting environment among energy purchasers and sellers. Since 2001, MAE was under the intervention of ANEEL, being then replaced by MBE.
- b) uncertainty as for the legislation – there is a high level of uncertainty among the energy trade agents as for the purchase and sale agreements, once several resolutions approved by the government overlay the existing resolutions.
- c) uncertainty as for the agreement accomplishment – it is associated with the uncertainty as for the bagasse volume available for energy co-generation and trade because, due to the risks inherent in the own agricultural production process (drought, fiber content, production breaks, etc), the mill may have difficulties in accomplishing the agreement clauses. These clauses determine that the mills must provide montly, during the round-up time, 95% of the hired energy volume, if not, they will be subjected to fines. The mills claim difficulties in

- assuming such risks due to the problems inherent in the co-generation process; and,
- d) uncertainty as for financing – it is associated with the delay of loans by BNDES. Without support from this institution, it is difficult to build a thermoelectric central in the mills, since the investment is high and its return is slow. The investment is viable only with different financing lines, with lower income taxes and higher payment time.

### **3.1.3. Data Structure**

It was observed that the agents do not have all data they need to make decisions. This data deficiency can be verified for the legislation and market value of co-generated electrical energy, whose rules are not consolidated.

This data structure might lead the agents to make some decisions not optimum for the parts, and indicates that these agents may need several control structures, implying costs for both parts.

### **3.1.4 Assets specificity**

It applies to the mills in process of co-generation commercialization, for the mills to generate energy surplus specific investments were made aiming uniquely at energy sale to the distributor.

A substation construction, purchase of new generators, boilers, multiple stages grinder turbines and the adaptation of the mill system to be in parallel with the distributor are considered specific investments.

If, for any reason, the energy agreement with the distributor is cancelled or interrupted, the mill will have to redirect the assets within the own mill or sell them, which will cause high losses of values used to implement the investments, which is estimated to be of a million dollars for each 1 MW.

The choice of spot market mechanism assumes the existence of high transactions costs that make the auto-producers think that short

term agreements or energy commercialization in the spot market have lower risks, as follow:

### **3.2.Trade costs present in commercialization of energy co-generated by the sugar cane sector**

The characteristics of the agreements analyzed following are those identified by economical agents as the ones which have become difficult the process of co-generated electrical energy commercialization.

#### **3.2.1.Warranties**

It is considered by the mills the existence of a high level of commercialization risk in the electrical energy market, either for long term agreements, where there is some indefinicion of energy fares values updating, or for short term agreements which had commercialization at MAE.

For the mills, the warranties are lower because, when setting an energy sale agreement, they are subjected to penalties and fines whether they can not manage to deliver the volume agreed. Thus, there is an effort of the auto-producers to fulfill the clauses.

When the mills were not able to deliver the energy volume agreed with the distributors, there was the option to acquire such volume from MAE and the mill could transfer the value for the distributor. With MAE extinction and the MBE not working fully, the problem of warranties are still present.

For the distributors, the risk is associated with the interruption or cancel of the energy sale agreement by the mills, generating supplying shortange. In this case, the mills will be subjected to agreement fines which correspond to the electrical energy present value that means na indemnification to the distributors. The distributors are also subjected to fines in case they interrupt or cancel the energy purchase agreement with the sugar cane mills. The fine value corresponds approximately to the agreement value (1/30 of the monthly income per day of delay), besides insurance. Both the mills and distributor

have no insurance for energy purchase and sale agreements. The existence or no with insurance cost will depend on the nature of the agreement.

### **3.2.2. Renegotiation cost**

There is a possibility of energy purchase and sale agreement renegotiation with the distributor. The mills consider that, due to the uncertainty inherent in the co-generation process, the agreements should have a greater flexibility, for example, reduction of the limit of 95% that the mills must deliver monthly during the round-up time. If the distributor needs to renegotiate the volume of energy acquired from the mills, there will be administrative costs. Distributors can annually renegotiate the energy prices and the amounts agreed with the mills.

For the mills, the renegotiation of energy volume agreed with the distributor is foreseen in agreement, since there are some mechanisms that make possible such alteration, although the supplying risks continue.

There are other clauses that foresee the renegotiation, such as:

- a) during the agreement, if there are changes in the legislation specific to electrical energy, influencing agreement dispositions, the parts will negotiate the adjust conditions. This can generate administrative and juridical costs for the distributor and mills. Legislation changes generate juridical costs, mainly when affecting the agreement economical financial balance. Constant change of the institutional environment has lead the agents to consider more or less relevant the trade costs;
- b) the energy insured by this agreement, which can not be supplied by the co-generator or can not be purchased by the concessionaire due to technical problems, could be compensate in the subsequent months, once there are technical conditions and agreement of both parts. Such compensation should occur withing the same civil year, and the conditions should be agreed among the parts.

In this case, if the energy agreed could not be supplied, the mills must pay a fine or indemnification to the distributor. The compensation mentioned in item (b) is subjected to a technical limit.

The mills consider relevant the administrative and juridical, agreement renegotiation and elaboration, and operational costs generated by such compensation.

### **3.2.3. Agreement elaboration costs**

These costs vary according to the number of energy purchase agreements. The higher the electrical energy amount offered by certain generation source, the lesser should be the number of agreements set by the distributor. In the case of the hydroelectric and gas and charcoal thermoelectric mills, the energy generation potential is high and a few purchase agreements should be enough for the distributors assure the volume necessary to attend all the costumers.

As for the aspect of agreement realization, it is observed that:

- a) due to a pulverized process of co-generation by the mills, the distributor should have a great number of agreements in order to obtain the energy volume necessary to offer to its consumers. This will cause a cost with trips, legal aspects, attendance and monitoring for the distributor;
- b) consultancy costs are considered internal for the distributor and do not affect the decision of commercialization. For the mills, electrical energy trade is a recent activity and consultancy costs are inevitable for the decision of beginning and/or expanding such trade. To elaborate purchase and sale agreements, there are also administrative costs and the ones with attorneys;
- c) the electrical energy co-generated by the mills is only commercialized during the round-up time, from May to November. Consequently, the distributor may have to count on the market to purchase energy, eventually with higher costs.

### **3.2.4. Information search and acquisition**

The Brazilian electrical energy sector reorganization has caused changes and instability in the electrical energy market. The rules have been changed frequently, making it difficult for the sugar cane sector to plan and take decisions, for example, the replacement of the MAE by BEM, in January 2002. Such instability can also be observed in the resolutions that overlay the existing ones, leading to a high level of uncertainty.

Another aspect of legislation raised by the agents who commercialize electrical energy is concerned to its inadequacy, since it is directed to big gas co-generation mills and not to sugar cane sector.

Constant overlay of rules and resolutions has led mills and distributors to a constant need for information search and treatment to minimize the risks about the decision to begin/expand energy commercialization.

### **3.2.5. Agreement monitoring and follow-up costs**

For distributors, during the agreement, several costs are relevant, such as displacement, stays, consultancy, management, measurement and monitoring, and, for the mills, consultancy and warranties costs are relevant.

### **3.2.6. Agreement safeguards**

Mills and distributors establish some safeguards to assure their interests, such as:

- a) warranty of seasonal energy supply by the mills to the distributor – it is established a seven-day tolerance from the date agreed so that the supplying can be regularized. From the eighth day, the mill should pay per day of delay a fine of 1/30 of the agreed monthly income. According to the distributor, the mills need this tolerance because, at the beginning of the co-

generation process, they cannot adequate their thermal balances. The mills may have problems with their equipment, such as boilers, generators and grinders.

In the technicians' opinion, the existence of this fine implies the need of reviewing the operational strategies. For the mills, the fine does not characterize as na obstacle, however, there should be a greater sensitivity by the distributor in relation to aspects inherent in the sugar cane mills and as for the understanding that this kind of clauses are acceptable to the sector;

- b) if there are changes in the regulation that demand alteration in the measurement equipment precision, the expenses will be paid by the co-generator. According to the distributor, the mills should be the responsible for the expenses mentioned in this item, since they are the most interested ones. For example, if the mill assumes to supply 10 MW and there is a loss, and the mill cannot reach the amount agreed, such loss is accounted to be discounted in the income; and,
- c) in case of programmed interruptions of energy supply to the concessionaires, the parts should adjust 72 (seventy-two) hours before, which may generate costs.

### **3.2.7. Legal aspects of non fulfillment of agreement clauses**

The non accomplishment of agreement clauses generates costs for the agents.

The failing by any parts causes the agreement cancel and payment of compensatory amount equivalent to 50% of the agreed value as amends of losses and interrupted profits.

As in the mills analyzed there were no event of this kind, they were not seen as obstacles to commercialization, however there is some doubt as for the eventual occurrence of these costs.

## **4. Conclusions**

The market of electrical energy co-generated by the sugar cane

sector presents characteristics that would naturally lead it to establish long term agreements, such as: high assets specificity (build of a electrical energy substation, transformation of grinder moviment turbine from single to multiple phase), need for supply regularity, reduced information structure and high uncertainty (due to problems of the market regulation) and high transaction frequency. What is verified is the opposite, the mills were commercializing the surplus in the spot market, the MAE, due to existing transaction costs that impede the process of hirement between mills and distributor.

These costs were observed for the mills which do not commercialize energy and are, mainly, the ex-ante costs, such as: information search and acquisition (mainly concerned to the constantly modified legislation); consultancies; and aggreement elaboration.

Ex-post costs were observed in mills which already commercialize co-generated energy, but do not explore the generation potential of surplus energy. These costs were: agreement warranties; insurances; monitoring and juridical follow-up; renegotiation and maintenance.

It is possible to assume that as the legislation is consolidated, the partnership among the agents will be strong enough to overcome such transaction costs, since this markets has presented profits perspectives, tht is, the benefits from commercialization surpass the transaction costs steill present in the market.

It is also to be assumed that the energy scenery of the country can influence this energy source development, since the search for alternative energy sources is less intense when the hydric availabiolity is higher, altering the relative price of the different sources, which may become difficult the development of alternative energy markets.

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