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A Proposed Model for Bioelectricity Cogeneration Activities Management in the Sugar-Energy Industry

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***Abstract*—*The aim of this article is to propose a model based on Balanced Scorecard (BSC) to run the strategy of the sugar-energy companies regarding to the business unit for bioelectricity cogeneration. The model adds three new perspectives to the BSC namely environmental perspective, human resources perspective and supplier perspective. Bioelectricity cogeneration will become indispensable for the modernization of the sugarcane mills that already accounts for 2% of the Brazilian GDP in the economic sector of the sugar-energy industry. The low cost of bioelectricity cogeneration due to the use of residual sugarcane biomass as raw material such as bagasse, straws and tips, which are wastes of the production of sugar and ethanol process is a strong incentive for the sugar-energy industry. The opportunity to supply bioelectricity to the Brazilian Interconnected Electricity System arose when an unusual dry period occurred in the Southwest/Midwest regions. The achieved results on a model running show that it can be a useful management tool. The scientific value of this study is to present a model that demonstrates the possibility of adaptation of the BSC with emphasis on meeting specific industry demand. In addition, an environmental problem solved using bagasse, straws, tips from sugarcane to produce electricity.*

Keywords*—Balanced Scorecard, bioelectricity cogeneration, sugar-energy industry.

I. INTRODUCTION

The Sugarcane plays a strategic role in the Brazilian economy. Research and Development investment supported by the Brazilian Government caused a relevant upgrade in the traditional sugarcane industry. In addition to the production of sugar and ethanol, a new business opportunity arose with the burning of bagasse to generate the electricity surplus in the mills in an operation defined as bioelectricity cogeneration (Vasconcelos and Carpio, 2017).

The surplus electricity (supply) from the sugar-ethanol industry became available to the National Interconnected System (SIN). The electricity crisis (demand) caused by low rainfall in the Brazilian Southeast-Midwest regions, where the major hydroelectric power plants with water reservoirs are located complemented this new business opportunity (Vasconcelos and Carpio, 2017; 2015).

Even the industry's name changed from sugar-ethanol industry to sugar-energy industry. As a new business, it is necessary to provide efficient tools, techniques and management practices to plan, monitorand finally assess positive financial and operational results for the new business unit administration in each mill.

The chain of the Brazilian sugar-energy industry sells US$ 43.6 billions in end-products representing about 2% of the Brazilian GDP (Vasconcelos and Carpio, 2017; Novacana, 2015). This value is equivalent to the economic output of countries like Paraguay, North Korea, Afghanistan, Jamaica and Estonia. The mills and the agents involved in the economic activity around the production of cane, sugar, ethanol and bioelectricity generate a gross revenue higher than US$ 100 billions per crop (Vasconcelos and Carpio, 2017; Novacana, 2015). These figures confirm the relevance of the sugar-energy industry for the Brazilian economy (Moraes et al., 2016).

According to IRENA (2016), the worldwide installed capacity to supply solid biomass for electricity generation reached 87,227 MW in the year 2015. Brazil is the country with the largest installed capacity, with 15.3% of the global total, followed by the USA (13.2%), China (11.8%), India (6.2%) and Japan (4.7%). The biomass source represents 9.03% of the electricity granted by the National Electric Energy Agency (ANEEL), which places

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it as the third most important source of electricity generation in Brazil.

The Chamber of Electric Energy Commercialization (CCEE) reported that in the month of July 2016, cogeneration from sugarcane biomass achieved its historical record, with up to 8.1% of the Brazilian electricity consumption generated by the sugar-energy industry (UNICA, 2016).

The sugarcane harvest occurs from April to November in the Southeast/Midwest regions of Brazil. This is the period when drought occurs, impairing the water replacement in the reservoirs of the hydroelectric power plants in this region. Note that the main hydroelectric power plants with reservoirs are located in these regions. About 70% of the hydroelectric power plants reservoirs capacities are concentrated in the Southeast/Midwest regions (Vasconcelos and Carpio, 2015).

Due to the shortage of rain that occurred in Brazil Southeast/Midwest regions during 2001/2002, the hydroelectric power plant reservoirs had the water level reduced to critical levels, which led to electricity rationing (Vasconcelos and Carpio, 2015). Government actions since then increased the share of thermal electricity generation in the Brazilian electricity mix.

Another period with low rainfall happened during 2014 in the regions where hydroelectric power plants with reservoirs are located (Vasconcelos and Carpio, 2015). In this new period of rainfall shortage (2014/2015), Brazil's major hydroelectric water reservoirs reached critical levels. Thus, the National System Operator (ONS) authorized the thermoelectric generation plants to maintain the supply, meeting the demand for electricity throughout the period in an uninterrupted way (Vasconcelos and Carpio, 2015).

Since 2004 the sugarcane biomass has been increasing its participation as an input for the generation of bioelectricity. According to the Brazilian Energy Research Company (EPE, 2015), the national policies promoted the diversification of electricity generation. The Brazilian Electricity Regulatory Agency (ANEEL) announced that there were 7.9 GW of installed capacity for the cogeneration of electricity by the sugar-energy industry, at the beginning of 2014. During the month of May 2015, this capacity expanded to 9 GW.

EPE (2015) reported that 177 mills with sugar-energy production units provided surplus of electricity to the SIN. Since the total sugar-ethanol mills reaches 355 production units (ÚNICA, 2016), there is still growth potential in the supply of bioelectricity (Vasconcelos and Carpio, 2017).

According to the ONS, each 1,000 average MWh of bioelectricity delivered to the SIN during the dry season means savings of 4% of water from the reservoirs of the Southeast/Midwest subsystem (Vasconcelos and Carpio, 2017; Castro et al., 2010).

In the Regulated Contracting Environment (ACR) market, new energy sellers that had participated in the bioelectricity generation auctions for the years 2014, 2015 and 2016 have also evolved positively, reaching the level of US$ 61.4/MWh in the LFA2015 auction (LFA: Alternative source energy auction only for wind electricity and bioelectricity). In April 2014, the cap-price of electricity on the Deregulated Contracting Environment (ACL) reached US$ 234.86/MWh (Vasconcelos and Carpio, 2017; CCEE, 2015).

In order to meet the need for strategic management of the sugar-energy industry new business unit, this article proposes a model to carry on a strategical execution of bioelectricity cogeneration unit with the use of concepts and practices based on Balanced Scorecard.

II. BALANCED SCORECARD

Charan and Colvin (1999) pointed out that in 70% of the failed business strategies the problem is not in their formulation, but in their execution. Martin (2016) commented some survey findings underscoring the well-established fact that few leaders (only 8%) are good at both developing effective business strategies and executing them. A successful execution of the company strategy occurs when three key business processes to achieve strategic results are in place linking business strategy with the real world. They are the people objectives, the business strategy and the operational plan (Bossidy and Charan, 2002). According to these authors, the company's management seeks to get things done on time and with the expected quality.

The budget process in a company explains the planned results. These results are revenue, cash flow and profits, and the corresponding resources. However, the budget process does not address how or if it is possible to obtain the expected results. This requires adopting a consistent operational process, based on a business plan that links strategy with short-term and long-term goals. In order to reach its planned results, a company addresses individual goals and defines employee responsibilities (Bossidy and Charan, 2002).

Kaplan and Norton (1992) presented the findings of their studies along with companies, detailing the feasibility of the processes and the description of the benefits achieved with the application of a balanced system of strategic measurement, that is known as Balanced Scorecard (BSC).

Few years later, Kaplan and Norton (1996) summarized the results achieved with the implementation of the BSC in companies as the main organizational tool for management processes. Some of these processes, such as setting individual and team goals, reward plans, allocation resources, planning and budgeting, feedbacking, recording and publishing of the strategic learning, should be considered.

According to Kaplan and Norton (1996), the BSC complements financial measures of the past performance with measures of vectors that drive the future performance. For this, BSC uses four perspectives namely Financial Perspective, Customer Perspective, Internal Processes Perspective, and Learning and Growth Perspective.

Innovative companies adopt the philosophy of the scorecard to manage the implementation of the strategy and enable critical management processes. These processes are (i) to clarify and to translate the vision and the strategy, (ii) to communicate and to link strategy objectives with measures, (iii) to plan, to set goals and to align strategy initiatives, and (v) to improve feedback and strategic learning. Finally, a tool to carry out the strategy must be put forth.

In the literature, the use of the BSC proposed to meet several needs.Among these, Epstein and Manzoni (1998) used the BSC to capture the complexity of the performance in the organization. Hauser and Katz (1998) used the BSC to choose the metrics that are critical to the success for actions taking and decisions. Kaplan and Norton (1992) used the BSC to establish measures to reflect and materialize the mission and the strategy of the company.

To achieve the purpose of the company as a whole, Kaplan (1999) suggested assigning the company scorecards gradually, distributing the implementation effort and also adjusting and refining the goals and needs in all sectors of the company.

Prieto et al. (2006) studied the main difficulties encountered overall, to create and compose a guide for the development of their research. They considered the comment of Kaplan (1999) about the complexity in developing and implementing a BSC management system in a company. For this, Prieto et al. (2006) proposed a discussion of “critical success factors” in implementing the BSC, change management processes and some techniques involved behind the scenes of the implementation. In some cases reviewed during their research, Prieto et al. (2006) concluded that the BSC conduction by middle management is often focusing on short-term results and metrics. Cao et al. (2015) developed some key performance ratios (KPI) based on “key success factors” for each original four BSC dimensions.

The human dimension in the BSC model is not ignored. Kaplan and Norton (1992) indicated that the human dimension is part of the learning and development activities. The human dimension has its basis on the employee development, supported by improving the implementation of internal processes.

Notwithstanding, Thompson and Mathys (2013) concluded that, like many organizations that use the BSC, it is imperative that the employee's perspective should be added to their scorecard. It is important to pay attention on a valuable additional element to the sustainability of the organization.

The research developed by Thompson and Mathys (2013) showed a strong link between employee engagement, customer engagement and improving organizational performance. They emphasized the focus on the employee engagement as a key factor to meet the customer's needs and to achieve the financial goals, with a direct impact on business profitability. Hence, the employee's perspective should be included in the BSC. An effective functioning of the organization requires proper management of the performance perspective of internal processes as well as workforce perspective. The learning and growth perspective then, becomes a source to develop employees in the execution of the key processes required to meet financial targets and customer’s expectations.

Through the alignment of the main perspectives defined by the senior leadership team, the company management can perform the measurement of the activities and implement the conceptual tools to build a culture focused on the employee with direct impact on the planned outcomes (Thompson and Mathys, 2013).

Zeng and Luo (2013) studied the BSC utilization in companies located in China. They presented barriers and obstacles regarding the implementation of the BSC in that country. They appointed two main obstacles such as the cultural barrier and adherence of the standards used by the BSC.

Two studies developed in Portugal (Guimarãeset al., 2010; Mendes et al., 2012) considered the application of BSC in the services of collection and treatment of solid waste.

Guimarães et al. (2010) discussed the potential application of BSC in managing the public service of waste collection into four types of provision of that public service, considering the optical of the service operator.

Guimaraes et al. (2010) analyzed management and direct operation by the city authority, as well as the use of public-private partnership. They focused on Portugal municipalities, semi-autonomous utilities, municipal companies and mixed companies. Among the findings of the case studies, these authors presented strengths in the use of the BSC as a strategic tool, such as increasing knowledge of the activities and identifying specific aspects that require a greater management attention.

Mendes et al. (2012) focused on the Urban Hygiene and Solid Waste Division of the Loulé Municipality in Portugal. They concluded that treatment of waste assists in implementing modern techniques and practices for waste management. They found evidences about focusing on the strategic management of the relationship with the client and server, and in ensuring positive combination for the improvement of services.

Norrie and Walker (2004) discussed ways to measure the progress of activities in project management during the project life cycle. They proposed the use of tools based on BSC to track the operational progress of the project team activities. They concluded that the project management becomes more effective in controlling and monitoring activities, in order to extend the results obtained by the project team after the adoption of tools based on BSC.

The main feature of the BSC in the strategy implementation management lies in the measurement of objectives and financial and non-financial ratios derived from both business vision and strategy. By using the BSC, the resistance to the controls and to the most significant goals is overcome by the participants due to the clarification of the causal relationships between the strategic initiatives (Kaplan and Norton, 1997).

The participatory process of implementing the BSC should involve all levels of the organization, not only the executive levels. Moreover, the BSC encourages communication between different areas of the company to complement the causal relationships within the multidisciplinary strategic objectives. The BSC translates mission and strategy into objectives and measures, organized according to four different perspectives such as financial perspective, customer perspective, internal processes perspective and learning and growth perspective. The scorecard creates a structure, a language to communicate to the organization the mission and strategy previously defined. The BSC uses ratios to inform employees about the vectors of the current and future success of their duties (Kaplan and Norton, 1997).

To use BSC companies have two main tasks. Firstly, it is necessary to prepare a scorecard, and then make good use of it. These two tasks are dependent. With the onset of the use of scorecards for key processes management, executives have a better understanding of the scorecard itself, realizing that if some steps do not work, which ones should receive specific changes and what are the new strategic process measures that arise and should be part of the scorecard. Kaplan and Norton (1997, 2004) explained that the construction of a BSC linking mission and strategy of a company to goals and explicit measures is just the beginning of the use of the scorecard as a management system. Through the communication, it is sought the alignment of all employees with the company's strategy, facilitating the establishment of goals and their subsequent fulfillment.

Kaplan and Norton (2004) proposed the Strategic Map to describe the logic for the connection of the strategy with the goals of the critical internal processes that create value to the business. For each defined process is stated the responsibility of each employee involved. The BSC translates the objectives of the Strategic Map into ratios and targets. To accomplish the objectives and goals, it is necessary to set and implement activities delegated to employees.

Therefore, according to Kaplan and Norton (2004), managers need to identify the strategic initiatives necessary to achieve the proposed goals. These initiatives provide results, since there are the strategy execution and monitoring of the progress of these initiatives. Action plans for strategic initiatives should have the correct alignment, as well as they should define and provide the necessary resources. They must have an integrated organization. With the expected results once financially described the Strategic Map, objectives are achieved and measured. Ratios according to the financial perspective of the BSC are used (Kaplan and Norton, 2004).

Most of the BSC published articles presented strategic development and implementation in a large variety of industries. There is additional published literature on BSC utilization by industries including the following contributions: Duarte and Machado (2015), Cheng and Liang (2014), Correa et al. (2014), Liu et al. (2014), Tjader et al. (2014), Xiaomei et al. (2013), Kunru (2012), Wu et al. (2011).

The practice shows that the strategy is not an isolated management process, but one of the logical steps in which are involved all collaborators (executives and employees) within the organization.

III. MATERIAL AND METHODS

The methodology proposed in this study focuses on the strategic execution of electricity cogeneration by sugar-energy industry. In addition to the BSC four original

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perspectives, as defined by Kaplan and Norton (1996), the proposed methodology adds three new perspectives to consolidate the implementation of the sugar-energy industry strategy. Environmental perspective, human resources perspective and supplier perspective defined to complement the proposed methodology as shown in Fig. 1.

Fig.1 – Proposed methodology with company's mission, strategy and execution connections

The environmental perspective considers for environment protection the pollution control, such as the quality of soil, air and water (Vasconcelos et al. 2017), the existence of filters to trap the soot from chimneys of boilers, the reuse of vinasse (Moraes et al., 2015; Christofoletti et al., 2013) to generate gas rich in methane through anaerobic digestion. The vinasse, after passing through the biodigestion process, together with the boiler ash and the soot from filters, can form a mixture for fertilization and irrigation of sugarcane fields. This perspective also considered the preservation of quality of the water used in the plant with proper treatment, its reuse and later discharge to the environment. Protection and restoration of the native riparian vegetation, the satisfaction and the commitment of local stakeholders are considered.

In the human resources perspective the focus is on the collaborators individual participation (employees and outsourced workers commitment and engagement) with the procedures and internal controls, the scheduled deliveries, ultimately with the company's success. This initiative leads to developing strategies and programs to support the employee activities and to building an engagement culture that expands the number of employees engaged in the workforce.

In the supplier perspective, emphasis is given to the relationship with the owners of fields leased for sugar-cane crop. Historically in Brazil, the inappropriate treatment given by the administration of the sugar-energy mills to farmers leads to further reduction of production due to crop exchange in subsequent seasons. Not getting the expected value for the lease of the lands, farmers leave the cultivation of sugarcane and immediately begin to grow other crops that can offer higher return, for example: grains such as soy bean and corn.

For each of the seven perspectives – namely the four original BSC perspectives and the three additional proposed perspectives – considered in the proposed methodology, the correlated processes with their respective objectives, ratios and targets are defined. These objectives comply with the logic applied in business management. Each objective was set to meet the expectations of the management team and of concern shareholders related to the strategy of a profitable company. This definition is the basis to allow the management team to measure the general productivity achieved. It is taken in account the strategic plan, company's mission, resulting actions from supplier perspective application in business and in relation to the environment protection. Table 1 shows the preview of the initial architecture with the chosen set of objectives and ratios for each one of the seven perspectives. Some correlated ratios are suggested.

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Table 1 – Proposed BSC

Perspective	Balanced Scorecard		Action Plan		Achieved Results	
	Objectives	*Indicators*	Target	Budget	Actual	Target x Actual
Financial	Increase the return to shareholders	ROI - Returns on investment				
		CROCI -Cash return on capital invested				
	Maximize asset utilization	Profitability				
		ROE - Return on own capital				
Customers	Service contracts	Marketshare				
		Contract net profitability				
		Customer satisfaction				
Suppliers	Keep long-term suppliers	Raw material cost				
		Land rental cost				
Environmental	Protect and preserve the enviornment	Effluent control and treatment				
		Native vegetation conservation				
		air pollution control				
		soil protection				
Internal Process	Optimize the use of assets	Equipment life cycle policy				
		Total quality procedures				
Learning and Growth	Developing skills	Employee profitability				
		Employees turnover				
Human Resources	Keep climate conducive to action through alignment and training	Employee engagement culture				

To meet the four original perspectives of BSC objectives typically used in companies of any industry were selected. Increase the return to shareholders and maximizing assets utilization are natural targets for the financial perspective. Generic ratios generally accepted in many industries are used to measure each objective.

3.1 Financial Perspective ratios

To increase the return to shareholders, selected ratios were return on investment – ROI and the cash return on capital invested – CROCI.

$$ROI = \alpha/\beta \qquad (1)$$

where:

α is net profit after interest and taxes

β is total of assets

Equation 1 is used to calculate the return on investment of the electricity cogeneration unit. It is a performance measure (ratio or indicator) used to evaluate the efficiency of the investment done.

$$CROCI = EBITDA/\gamma \qquad (2)$$

where:

$EBITDA$ is Earnings Before Interest, Taxes, Depreciation, Amortization, Rent and Management fees

γ is Capital Invested

Equation 2 is used by management team to calculate the cash return on capital invested on electricity cogeneration business unit, calculated on a cash basis.

To maximize the use of assets, the selected ratios were: profitability (profit margin) and return on own capital - ROE.

$$Profit\ Margin = \delta/\lambda \qquad (3)$$

where:

δ is net profit

λ is total sales

Using Equation 3 the management team measures the amount of net income earned with the electricity sales. This ratio measures how effectively the business unit can transform sales into net income, which means the efficiency of the electricity generation unit.

$$ROE = \delta/\eta \qquad (4)$$

where:

δ is net profit

η is net worth

Equation 4 indicates the profitability of the electricity cogeneration business unit. It measures the shareholders earning based on investment done in the business unit. The higher the ratio is, the more efficient the management is.

A similar logic was adopted for the definition of objectives and related ratios for the other three original perspectives of BSC, the customer perspective, the perspective of the internal processes and the learning and growth perspective.

3.2 Customer perspective ratios:

$$Marketshare = \lambda/\rho \qquad (5)$$

Where:

λ is total sales

ρ is total bioelectricity market

Equation 5 is used to calculate the participation of the electricity cogeneration business unit in the relative market. Using marketshare ratio, the management team have a view of the position occupied by their business unit in comparison with other companies in the cogeneration market.

$$Contract\ Net\ Profitability = \lambda - \partial \qquad (6)$$

where:

λ is total sales

∂ is total production cost

Equation 6 is used to have a better view of individual contract signed to sell electricity in both ACR and ACL markets.

3.3 Customer satisfaction – $Csat$

$$Csat = v/o \quad (7)$$

where:

v is number of customers whose reported experience exceeds satisfaction goals

o is total number os customers

Equation 7 is used to calculate the customer satisfaction ratio based on reported satisfaction informed by each customer. Due to electricity is a commodity this ratio has a high difficulty degree to be calculated. In general, the mill management team can carry on a customer satisfaction survey on yearly basis to inform shareholders as part of the annual balance

3.4 Internal Processes Perspective ratios

Equipment life cycle policy

Total quality procedures

No ratios are suggested for internal processes perspective due to the necessity to define and use, in each company, specific ratios related to Total Quality Management (TQM) and life cycle policies and programs.

3.5 Learning and growth Perspective ratios

$$Employee\ profitability = \delta/\mu \quad (8)$$

where:

δ is net profit

μ is number of employees

Equation 8 is used by the management team to control the individual contribution of each employee to the profitability of the electricity cogeneration business unit.

$$Employee\ turnover = \theta/\mu \quad (9)$$

where:

θ is number of fired employees

μ is number of employees

Equation 9 is used to verify the turnover during the period. Depending on the ratio calculation results, a specific management action should be taken on human resource area.

For the three perspectives proposed by the model such as the supplier perspective, the environmental perspective and the human resources perspective, objectives and specific ratios were defined. These ratios were adapted to be used in a electricity business unit cogeneration of a sugar-energy industry company.

3.6 Suppliers Perspective ratios

For the supplier perspective, it was considered the importance of this perspective for the industry and for the business unit of electricity cogeneration. The point selected for the supplier perspective was to keep suppliers long-term assets.The importance of the supplier perspective for the sugar-energy industry is evidenced by the need to keep the productive fields for long period, since, depending on the type of sugarcane grown a sugarcane crop can remain productive for up to fifteen years.

The ratios defined for the supplier perspective are raw material cost participation and land rental cost participation.

$$Raw\ material\ cost\ participation = \tau/\partial \quad (10)$$

where:

τ is raw material acquisition cost

∂ is total production cost

Equation 10 is used to manage the total cost of raw material acquisition. The purchase of sugarcane from farmers without contract previously signed is one of the application of this ratio. Another one is the extra purchase of bagasse from nearby mills to increase the electricity cogeneration out of harvest period.

$$Land\ rental\ cost\ participation = \varphi/\partial \quad (11)$$

where:

φ is land rental cost

∂ is total production cost

3.7 Environmental Perspective ratios

On the environmental perspective, tje protecting and preservation of the environment were the main objective. As its primary input is the sugarcane,this objective is important for the sugar-energy industry. The sugarcane crop needs large fields, typically located in areas without artificial irrigation. Native vegetation and riparian areas are cleared to enlarge the productive area. The industrial process of production of sugar and ethanol generates waste pollutants, such as bagasse and vinasse in great proportions. Ratios are defined to the control and treatment of effluents, the conservation and protection of native vegetation, and soil protection.

$$Native\ vegetation\ conservation = \omega/\vartheta \quad (12)$$

where:

ω is native vegetation area

ϑ is total area

Equation 12 is used to control the actions on environment care, such as the ratio of native vegetation last as well as reforestation actions taken on mills property. Depending on calculated ratio, this information could be used by public affair department.

Air pollution control through chimneys filters performance to be controlled according to filter specifications.

Effluent control and treatment of disposed water.

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Soil quality protection to maintain optimal chemical composition of soil.

3.8 Human Resources Perspective ratios

Human resources are the main productive factor of any industry. Therefore, the human resources perspective was included in the model. In the original BSC, there is already a weight set in the performance of the employees. Subsequent authors have presented benefits of employees to have professional treatment to achieve the strategic company objectives. In the proposed model, human resources received additional importance because in the sugar-energy industry there is difference in the treatment of individual employees.

Thus, the objective set for the human resources perspective to maintain favorable climate to ensure the alignment of employees with the company's goals and due to qualify and develop human resources. The proposed indicator is to keep a positive organizational action throught the maintenance and encouraging the culture of employee engagement with the company policies.

$$Employee\ engagement = \kappa/\zeta \qquad (13)$$

where:

κ is total employees objectives already achieved

ζ is total of employees objectives

Equation 13 is used to calculate the participation of each employee in the effort to achieve the strategic results of the electricity cogeneration business unit.

3.9 Targets definition

At this point, it is necessary to establish measurable targets for each objective indicator. The objectives for each perspective are defined with detailed ratios, considering their quantification and the way to present planned results.

Targets should be set in two ways. Considering increase percentages over the previous period,e.g. increasing by 3% the revenue that had been earned in the period before for the electricity cogeneration unit. Another option is to consider a new percentage reached by the new target, e.g. increasing 2% the share in the bioelecricity cogeneration market in the next fiscal year.

Up to now it has been defined, for each perspective, the objectives, the ratios used to measure the results and the upcoming period desired targets to be checked against the previous period, e.g. year, semester, quarter, or month.

3.10 Implementation

Once the plans are approved, development activities are managed (monitored, supervised and controlled). Hitherto, the proposed methodology have passed through the periods of planning and development (when the execution takes place), to achieve the strategic objectives of the business unit and hence of the organization, in a given time period. To complete the proposed methodology, it is still necessary to present the achieved results (actuals) and to checkagainst the planned results (target) from the approved plan.

After comparing planned objectives with the achieved results, management decision is necessary. These strategic decisions ensure that some adjustments may be necessary and enough to start a new cycle of planning, execution and control in order to carry out the future business strategy of the sugar-energy industry.

To implement the proposed methodology and use it in an efficient way, six steps proposed by this study should be executed in the sequence (Fig. 2):

Step 1: Define objectives for each one of the seven perspectives;

Step 2: Define ratios to be used to measure progress of each objective;

Step 3: Define and approve action plan (target and budget) values for each indicator defined in Step 2;

Step 4: Measure results already achieved for each indicator (target x actuals);

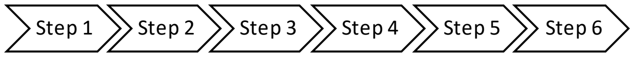

Fig.2 – Logical steps on the proposed methodology

Step 5: Make corrections when and where necessary;

Step 6: Approve achieved results.

IV. RESULTS AND DISCUSSION

There are many well established companies in the sugar-energy industry in Brazil. In recent decades, the operations of multinational groups consolidated with investment in the industry through acquisition as well as establishment of new businesses.

At the same time, national groups strengthened during the recent growth period of the Brazilian economy and followed the same path. Driven mainly by the government incentive program for ethanol to replace and to complement the use of gasoline in Otto-cycle motor engines, many national groups increased their investments in the sugar-energy industry.

Dependent on pricing policies for ethanol – historically linked to the price of gasoline –, which have always been handled by the federal government in order to contain inflation, the entrepreneurs of the sugar-energy industry make use of official loans and tax incentives. The construction of plants to produce only ethanol was encouraged by the government and the entrepreneurs were at the mercy of the controlled official prices.

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Yet the plants that produce ethanol and sugar have had more room to choose the type of product to be manufactured, according to the demand behavior in Brazil and overseas. In this case, business owners seek the best return based on international price fluctuations of sugar and ethanol commodities, traded on the Chicago Board of Trade. Thereby, the production of sugar and the production of ethanol alternate.

For electricity, there is no export market and the domestic demand follows the programming and the centralized decision to electricity delivery made by the National Operator of the Electricity Network (ONS). The sale of electricity in the regulated market (ACR) occurs through auctions organized by local authorities. Electricity sale on the deregulated market (ACL) has the maximum price set by the government. Transactions on the ACL directely negotiated by vendor companies with the consumer companies.

In larger sugar-energy companies, the introduction of a new front to meet the demand for bioelectricity treated as a new business unit. The administrative and strategic company internal processes are practiced also in the new business units. Data collected from the daily operation are inputed into the modules of the integrated management systems. The accounting, financial and management data obtained is jointly processed by the integrated computer systems of each company.

During visits to four plants located in the region of Grande Dourados, Mato Grosso do Sul state, Midwest region of Brazil, it was observed that the electricity cogeneration does not receive adequate management attention. The visited mills neither use bagasse, tips and straw from sugarcane to produce second-generation ethanol nor use vinasse in the anaerobic biodigestion process to produce biogas.

Based on the obtained answers and through direct observation during those four visits, it was found that there is no specific tool for managing the electricity cogeneration. Furthermore, the transformation of the traditional sugar-alcohol industry into a new sugar-energy industry has a representative impact on company financial and operational results and is more than a simple inclusion of a new business unit in each mill.

In one of the visited mills, the proposed methodology was tested using actual data. Once analyzed, the management decision considered the obtained results positive and useful for the business.

3.1 Methodology application

Following the proposed methodology, the six logical steps (Figure 2) were executed. Objectives and ratios for each one of the seven perspectives (Figure 1) were defined to consolidate a business unit of electricity cogeneration. The taken decision was to use the objectives and ratios as proposed in Figure 1.

The selected mill processed 2 million tons of sugarcane in the year-one harvest. According to the industry standard, 1 ton of sugarcane produces 250 kg of bagasse at 50% moisture and 205 kg of straw and tips (UNICA, 2015).

According to installed boilers capacity, 1 ton of bagasse fed into a boiles is enough to produce up to 14 MW. For the industrial process, there is up to 40% of the electricity produced for internal consumption (during the harvest period) and the rest (60%) supplied to bioelectricity cogeneration process. As the harvest period lasts 8 months a year, 4.7 GW of bioelectricity are available for cogeneration per year.

The sale of the bioelectricity produced occurred as follows: 70% to meet the ACR contracts, whose price was set in US$80.00 per MWh. The remaining 30% to be negotiated in the ACL, at the average price of US$82.86 per MWh.

For the following year, called year-two, the set goal was to expand the sale of electricity in the ACL by 10%. For the planned additional cogeneration, there is the burning of straw and tips collected from the sugarcane fields, soon after the harvest.

The collection of straw and tips is to be up to 60,000 tons. It is worth mentioning that there will be no negative impact on the next sugarcane crop harvest, as more than half of the straw and cut tips remain on the ground. Table 2 tabulates the details of the achieved results.

Table 2 – Electricity cogeneration business unit. Year-one and Year-two production

Description	Year-One	Year-Two
Production (sugarcane ton)	2,000,000.00	2,000,000.00
kg bagasse/sugarcane ton	250.00	250.00
kg straw and tips/sugarcane ton	204.00	204.00
ton of producted bagasse	500,000.00	500,000.00
ton of harvested straw and tips	0.00	60,000.00
GW generated	7.80	8.60
GW delivered (cogeration)	4.70	4.84
Sold ACR	3.30	3.30
Sold ACL	1.40	1.54
ACL contracts average price - US$	80.00	84.29
ACL contracts average price - US$	82.86	91.43

With straw, tips and bagasse, there will be enough raw material to feed the boilers during the harvest period as well as one of the boilers that remain working in the off-season specifically for bioelectricity cogeneration. Cogeneration takes place during 12 months without interruption in the year-two. This means that besides the eight months of normal harvest, the cogeneration of bioelectricity will last four additional months in the year.

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In this additional period, the total bioelectricity generated is sold since the ethanol and/or sugar production lines are not in operation activities.

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation.

V. CONCLUSION

This article aimed to present a model to run the strategy of the bioelectricity cogeneration with the use of concepts and practices based on the Balanced Scorecard. The need for better planning and monitoring of results for each mill as a whole and especially for the business unit of electricity cogeneration is an issue. It uses the sugarcane bagasse as raw material, which is a by-product of the production process of sugar and ethanol. The straw and tips that were selected during the cutting and harvesting of sugarcane crop, which were scattered throughout the field to serve as protection and fertilizer, can be collected at the ratio of up to 50% and may be burned in boilers together with the bagasse, or even separately. Thus, a new business perspective opens up with the selling of electricity in the ACL market during 12 months a year. Consolidating the electricity cogeneration activity in companies of the sugar-energy industry, it is clear that there is a need to use techniques and management practices to monitor and assess results of the new business unit. As well, it proposed the use of a model for physical monitoring of financial and operational activities developed from an adaptation of the BSC.

The article demonstrated the achievement of the positive strategy with the properly measurement and management. The proposed management model with three additional perspectives provides for literature an improved alternative to use Balanced Scorecard.

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