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ECONOMIC VIABILITY STUDY OF AN ENERGY COGENERATION PROJECT FROM SUGARCANE BAGASSE

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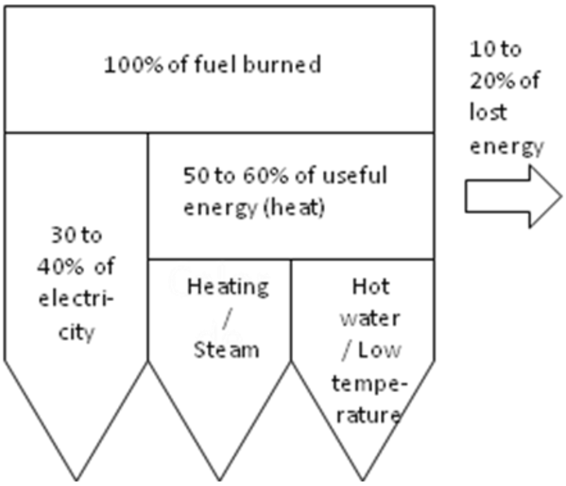
This study aims to analyze the economic viability of a cogeneration power project that uses sugarcane bagasse as fuel. The project consists in a thermal plant of 30 MW of installed capacity, having its dispatch regime associated to the prodduction of the sugar and ethanol mill. The methodology used in the analysis is the Discounted Cash Flow. In the assumptions, the energy generation of the plant was linked to the harvest period of the sugarcane, estimated in 180 days per year, and the operational regime of the plant was established as full (base load) with a capacity factor estimated in 92%. Through a selling price estimated by analogy with recent energy auctions and a self-consumption of 30% of the energy produced, the financial model generated an internal rate of return comparable with the Electrical Energy Index (IEE) of the Brazilian Stock Market (Bovespa), the Bovespa Index (Ibovespa) and the Interbank Deposit Certificates (CDI). The theoretical referential of this work brings considerations about the cogeneration process and its advantages.

Palavras-chaves: Cogeneration, sugarcane bagasse, economic viability

1.1.

1. Energy Cogeneration

Cogeneration is the simultaneous generation of electrical power and thermal energy through a single fuel. Studies estimate that this kind of generation has an efficiency of more than 70% of the energy available in fuels (COGENRIO, 2009), as figure 1 indicates. Cogeneration allows, therefore, generating more energy with the same amount of fuel, which means more economy and some reduction in the greenhouse gas emissions.



Source: COGENRIO (2009)

Figure 1 – Losses in energy cogeneration

Cogeneration may use several fuels, like natural gas, diesel, residual fuel oil, process gas and biomass (sugarcane bagasse, vinasse and black liquor). The sugarcane bagasse is a residue of sugar and ethanol production. The bagasse (or any other fuel) is burned inside a burning boiler, heating the water and generating steam. Studies show that a burning boiler takes about 10 hours since its start until it gets fully ready (BOTÃO & LACAVA, 2003).

In cogeneration, the biggest part of the energy generated is thermal, and the rest of it is in the form of electrical power. A sugar and ethanol mill usually uses an amount of electric power of 30 kWh per ton of crushed sugarcane. This energy is used in the machinery and in several electric motors. The consumption of thermal energy through steam for the production process is approximately 300 kWh/ton of crushed cane (300 kWh/tc), ten times bigger than the electric power consumption (PROCKNOR, 2009). According to RAMOS *et al*. (2009), the steam is used in the mill industrial equipment.

Cogeneration produces more thermal energy (TE) in the form of steam than electric power (EP), which explains the reason why it is largely used by sugarcane mills. The smaller the coefficient EP/TE is, the more adequate the use of cogeneration is. In sugar and ethanol mills, this coefficient is approximately 0.1, very low when compared to other industries, which is why the cogeneration is so attractive (PROCKNOR, 2009) in this case.

Nowadays, most of the mills, if not all of them, have a cogeneration system for its own consumption. However, the generation of electric power surplus has become in evidence as a way to increase the mill's operating margin. Table 1 shows the production and consumption of energy in the sugar and ethanol production considering different pressures in the burning boiler.

Steam	EP consumed (kWh/tc)	EP surplus (kWh/tc)	TE consumed (kWh/tc)	Total useful energy (kWh/tc)	EP/TE
22 bar / 300°C	30	0	330	360	0.09
62 bar / 480°C	30	40	330	400	0.21
82 bar / 515°C	30	60	330	420	0.27

Source: adapted from LEAL (2007)

Table 1 – Relation between TE and EP in the mill

The mill consumption of EP, in this example, is 30 kWh/tc, and of TE is 330 kWh/tc (which is equivalent, in energetic terms, to the consumption of 500 kg of steam per ton of crushed sugarcane). This results in a total useful energy (TUE) of 360 kWh/tc. In the first example, it was considered a burning boiler with a 22 bar pressure operating in a temperature of 300º C, in which is possible to meet the mill's energy consumption without generating energy surplus, though. The EP/TE coefficient is, in this case, 0.09, close to the 0.1 previously cited.

Through the use of burning boilers with higher pressure (62 bar) and temperature (480ºC), it is possible to generate an electric power surplus of 40 kWh/tc, which makes the EP/TE coefficient rise to 0.21. The same occurs in the third example, with an increase in the electric power surplus generated and in the coefficient. A similar effect could be obtained by keeping the steam flow from the burning boiler and reducing the steam consumption in the sugar and ethanol production, so the steam surplus can be used in electric power generation. Yet, both alternatives can be combined. Nowadays, many mills still use low pressure burning boilers, wasting the energetic potential in the bagasse.

The electric power surplus can be sold in the unregulated environment (free market), through a contract signed with a free customer. In this case, the price is negotiated between the customer and the mill. In the regulated environment, the enterprise must participate in an auction and, if the sale price is competitive, it can be sold in the energy market.

The process described above is the simple cogeneration, which is the conventional technology used today in the mills. There are new technologies that allow increasing the generation of electric power in spite of the thermal energy, through combined cycle, in which a gas turbine is used to generate energy through the bagasse burning and the hot exhaustion gases. These are redirected to a recuperation burning boiler, where the steam is used in the turbo generator, generating an electric power surplus. In order to turn it possible, the bagasse must be gasified and the resulting gas that will go to the turbine must be purified. This technology is known as BIG/GT, abbreviation of Biomass Integrated Gasifier Gas Turbine). Besides that, the use of this process implies in a smaller thermal energy generation and, therefore, the consumption of steam in the industrial process must be reduced as well. The technical barriers impede the commercial use of this technology nowadays (LEAL, 2007).

2. Advantages of cogeneration through sugarcane bagasse

Besides being environmentally friendly, the use of the biomass promotes the development of economically less favored regions, through job creation and revenue generation, contributing positively to the rural migration problem and to the external energy dependency, due to the local energy availability.

Table 2 shows that, geographically, 46% of all the energy installed capacity of plants using sugarcane bagasse is in the state of São Paulo, which has a great importance in the sugarcane culture (ANEEL, 2009).

Region	Capacity (MW)	Share (%)
North	74	1.3
Northeast	912	15.9
South	762	13.3
Southeast	3,300	57.5
Center-West	690	12.0
Brazil	5,737	

Source: adapted from ANEEL (2009)

Table 2 – Power generation through bagasse by geographical region

The sugarcane industry is mainly devoted to the sugar and ethanol production, but its participation in the Brazilian energy matrix is getting bigger. The high productivity obtained by the sugarcane culture and the increase in the productivity of the sugar and ethanol production allowed the generation of a great amount of bagasse surplus in the mills, which are used in the electric power generation. In terms of its energetic content, the bagasse represents 49.5% of the sugarcane (ANEEL, 2005). The use of this fuel as an electric power generation source is increasing due to innumerous advantages:

a) Low operational cost: the bagasse is a residue of the sugar and ethanol production process and, thus, the power generation through this fuel doesn't imply in raw material acquisition, that, in conventional thermal plants, is one major cost;

b) Complement in relation to hydropower generation: the sugarcane harvest in the South-Center region occurs in the dry season of the year (most of the time the harvest happens in winter), when it rains less. This means that while the hydropower plants reservoirs are empty and, therefore, with a low power generation rate, the cogeneration plants are operating. It is, thus, a way to avoid the starting of thermal generation through more expensive fuels during this dry period;

c) Low logistical cost: as the cogeneration plants must be near the sugarcane mills, the logistical cost of the bagasse is irrelevant to the electric power generation;

d) Proximity to the consumption centers: the sugarcane mills are close to the consumption centers, if compared to the great hydropower plants, which are located far from the cities. It reduces the electrical energy transportation losses that occur in the transmission lines.

e) Fast implementation: construction takes, in average, from 18 to 24 months (NEGRI, 2007);

f) Brazilian technology: the cogeneration equipment is already developed and produced in Brazil. It helps the country by generating wealth and jobs, and allows to obtain financing at a cheaper cost within, for example, the Social and Economic Development National Bank (BNDES);

g) Clean energy generation: the carbon dioxide emission in the sugarcane bagasse burn is lower when compared to fossil fuels. Besides that, there is a consumption of that gas in the sugarcane crop, through the photosynthesis chemical process. The sugarcane bagasse is a renewable energy source and doesn't emit toxic gases like the sulphur dioxide (SO_2) in its burn;

h) Distributed electric power generation: the cogeneration through sugarcane bagasse may be characterized by small units close to the consumption centers. For this reason, it doesn't depend on the large integrated transmission lines that are part of the national integrated system (SIN) and that serve the major part of the country, increasing the reliability in the electrical system. The blackout, that occurred in Brazil in Nov 10, 2009, was caused by an error in the electrical power transmission system, which affected many states. That fact caused a huge discussion in favor of distributed electric power generation, so that the country doesn't depend entirely on the SIN. This distributed way of generating energy applies to the sugarcane bagasse (and other sources of biomasses) and to the Small Hydropower Plants (PCHs).

3. Economic Viability Analysis

The first assumption to be defined is the potency of the cogeneration plant, which will vary according to the crushing capacity of the sugarcane mill in which the plant will be installed (the cogeneration system must be restricted to the amount of bagasse available). In order to study this assumption, a 30 MW installed capacity will be used, which is a reasonable metric to this sector.

The annual energy generated depends on the installed capacity and on the number of operating days. The plant operates 24 hours a day (full load) during the sugarcane harvest, which lasts six months in average (or 180 days per year). The capacity factor, which considers the fraction of energy effectively generated from the installed capacity, is of 92%, and the remaining 8% is due to losses and maintenance. Therefore, the amount of energy effectively generated in a year is 119,232 MWh.

The sugarcane mill will consume only part of the electric power generated in its production process, and the energy surplus can be sold in the electrical grid, generating extra revenue. In this study, the mill will consume 30% of the available energy, and 70% will be sold in the grid. Thus, the energy balance will be as shown in Table 3.

Installed capacity	30	MW
Operational days per year	180	days
Operational hours per day	24	hours
Capacity factor	92	%
Total power generation	119,232	MWh
Sugarcane mill own consumption	35,770	MWh
Power surplus sold to the grid	83,462	MWh

Table 3 – Operational data

Moreover, it is necessary to establish in which modality the electrical power will be sold. In this study, it was considered a sale in the regulated market through auctions.

In the energy auction held on Sep 30, 2008, a thermal plant operating with sugarcane bagasse as fuel won a contract at a price of R$ 145.00/MWh. Later, on Aug 27, 2009, the sugarcane bagasse thermal plant won the bid at a price of R$ 144.60/MWh. Therefore, for modeling purposes, the price assumption will be R$ 145.00/MWh, which is compatible with the previous auctions results.

The costs for bagasse cogeneration plants were collected from the Energetic Research Company (EPE). The prices summarized in Table 4 correspond to:

a) ANEEL’s inspection fee amounting R$ 1.52 per kW of installed capacity, per year;

b) Operations and Maintenance (O&M) are expenditures related to machinery maintenance and plant operation. It can be split into fixed and variable parts. The latter will be estimated as R$ 6.00 per MWh; the former will be estimated as R$ 25.00 per kW of installed capacity, per year;

c) The tariff for the grid usage (TUST) amounting R$ 5.00 per kW of installed capacity is levied on the load wheeled by the generator through the transmission lines. According to ANEEL (2004a), this amount must be paid every year on a monthly basis, even when generation is held only during six months, as in this case. The ANEEL Normative Resolution nº 77 of Aug, 18, 2004 (ANEEL, 2004b) grants a 50% reduction for biomass power plants, limited to projects with base load capacity equal or below 30 MW. Once losses are estimated as 2.4 MW, the resulting net base load capacity is 27.6 MW. The own consumption required to run the sugar and ethanol mill is 8.3 MW, therefore 19.3 MW are expected to be wheeled throughout the grid;

d) The operational insurance is required to cover machinery breakdown, third parties injuries and loss of revenues. On average, its annual premium amounts 0.3% of the CAPEX.

The R&D fee amounting 1% is levied on gross operational revenues, net of taxes charged under the Social Integration Program (PIS), the Social Security Contribution (Cofins) and the ANEEL’s inspection fee. However, according to Silva (2008), there is one incentive waiving cogeneration plants from this duty, therefore, for the present study; such tax will not be taken into account;

ANEEL’s inspection fee	1.52	R$/kW
Variable O&M	6.00	R$/MWh

Fixed O&M	25.00	R$/kW
TUST	5.00	R$/kW
Operational Insurance	0.3	%CAPEX

Table 4 – Cost assumptions

The CAPEX is expected to be R$ 2,272.91 per KW of installed capacity, an average calculated by EPE (2008) from similar plants.

The taxation on operations shall be considered so far. In this case, 1.65% of PIS and 7.6% of COFINS are levied on the gross operational revenue. Moreover, the corporate income tax (IRPJ) of 15% and the social contribution (CSLL) of 9% are both levied on earnings before taxes (taxable income). The former has a 10% supplementary tax on the portion of taxable income which exceeds R$ 240,000.00 per year.

Revenues and costs are adjusted annually by the inflation rate (escalation). The ample consumer price index (IPCA), adopted in this study, has shown a consistent descent tendency. Until Oct 2009, the 10-month accumulated inflation was 3.5%, lower when compared to previous years, mainly due to the world crisis which halted Brazilian economic growth. In 2010, thanks to the market recovery, it is expected that the inflation will scale up to the 4.5% target (BACEN, 2009a, p. 2). For the next years, the model foresees a gradual reduction of IPCA until the 5th year, being leveled at 3% since then. This situation is summarized in Table 5, considering that year “0” is when construction takes place. It means that in such year the capital has been totally expended, making it as the starting point for the project forecasts. The plant starts operating in year “1”, when escalation starts inflating the cash flow.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	…	Year 21
IPCA (%)	0	4.5	4.0	3.5	3.5	3.0	...	3.0

Table 5 – IPCA forecast in the model

Moreover, the project was evaluated with and without financing. The leveraged project (with financing) has its basic conditions described in Table 6.

Debt ratio	76.5	%
Interest rate	9.0	%
Amortization period	14	years
Grace period	1	year
Amortization approach	Fixed	

Table 6 – Financing assumptions

The leveraged amount accounts for 76.5% of the CAPEX. This amount is capitalized during one year (grace period) by a 9% interest rate. The debt outstanding at the end of the first year is the principal plus the capitalized interest. At the end of the second year, the amortization period starts up by means of fixed installments.

4. Income Statement and Cash Flow

Annex 1 shows the income statement and the leveraged cash flow, which together contains the debt service comprising interest due and principal amortization and the main operating costs, that are split into fixed and variable O&M, tariff for the grid usage (TUST), the ANEEL inspection fee and the insurance. As far as the cogeneration power plant is attached to the sugar and ethanol plant, additional administrative employees are not required.

Depreciation affects the cash flow only through its impact on income taxes. Depreciation is not a cash expense; it is simply a way to spread the CAPEX over the asset's life. To calculate the shareholder free cash flow, depreciation must be added to the net income

Working capital is allocated in order to finance current liabilities only for the first month. The operational revenues are expected to be large enough to fund the next current liabilities even when the cogeneration plant is offline.

For the calculation of the weighed average cost of capital (WACC), equity cost (Ke) and debt cost (Kd) were considered. The latter is the debt interest cost, estimated at 9.0% in this assessment. The WACC is expressed as:

$WACC = Ke * (E/(E+D)) + Kd * (D/(E+D)) * (1-t)$, where:

Ke: equity cost, estimated at 12% per year;

E: equity;

Kd: debt cost, estimated at 9% per year;

D: debt;

t: effective tax rate (IR and CSLL)

The WACC increases every year due to the increase in the equity share. Such modification in the capital structure happens during the amortization period.

The effective tax rate is the amount of taxes (IR and CSLL) levied on the income before taxes. The tax rate varies according to the level of taxable income. Corporate tax income has a 10% supplementary tax on the portion of taxable income which exceeds R$ 240,000.00 per year.

There are two approaches for the discounted cash flow. The first is calculated by escalating the cash flow, that is, by adjusting the inflation for inflows and outflows. The second is calculated by using the model in constant terms, that is, without inflation. In this case, the discount rate must be adjusted, by removing the inflation effect and treating it as a real rate, instead of a nominal one. This is not the case in our assessment, once we adopted the escalated cash flow. The escalation should be removed in order to achieve the real discount rate.

The advantage of such approach is the possibility to easily compare the project with other sources of investment in nominal terms. The cash flow was escalated by the Ample Consumer Price Index (IPCA).

As stated in Annex 1, the internal rate of return for the shareholder calculated from the estimated leveraged cash flow is 14.67% per year, higher than the Minimum Attractive Rate of Return (MARR) or the equity cost of 12% (Ke). The discounted payback period, calculated from the discounted cash flow, is 17 operational years.

The net present value (NPV) is calculated from the cash flow without debt in Annex 2, as far as the WACC is the discount rate. The resulting summation of the discounted cash flow is the NPV, which is much bigger than zero, confirming the project economic feasibility. Table 7 summarizes the results.

IRR	14.67%
Payback period	10 years
Discounted payback period	17 years
NPV	R$ 11,756,246.50

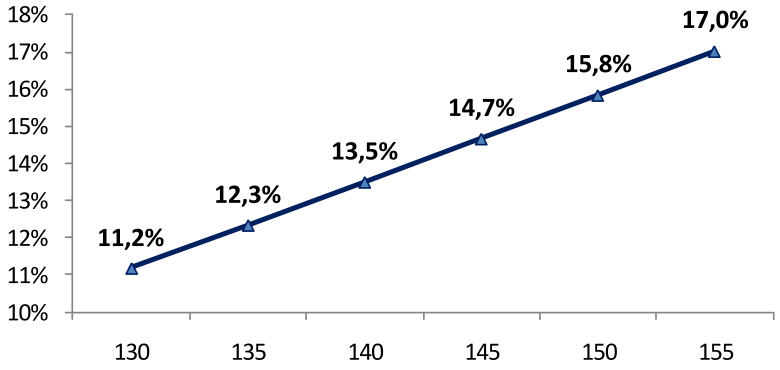
Table 7 – Summary of Results

The projected IRR for a twenty-year-term is nominal. By offsetting 4.5% of escalation from de debt cost, it decreases from 9% to 4.5% per year, resulting in an effective IRR (not considered inflation) of 13.52% per year. The appreciation of some other comparable investments can be matched with the effective IRR of the cogeneration project. For instance, the Electrical Energy Index (IEE) of the Brazilian Stock Market (Bovespa) appreciated 12.9% per year, on average, for the last ten years (from Jan 2000 until Mar 2010). For the same period, the Bovespa Index (Ibovespa) appreciated 7.7% per year and the Interbank Deposit Certificates (CDI) yield was 8.62% per year. These indexes were calculated in real terms, based on as escalation of 94% along this period, measured by the IPCA. Although the terms under analysis are not the same, the effective IRR of the cogeneration project resulted above the real return of all these three alternatives.

5. Sensitive analysis for the Energy Sale Price

The main objective of the sensitive analysis is to show alternative scenarios for our assessment, that is, to evaluate how some changes in the assumptions may affect the project return. Therefore, the IRR of 14.67% will be adopted as the metrics for comparison.

The average sale price estimated as a reference for this model is R$ 145.00 per MWh, according to the historical auction prices for biomass projects. For sensitive analysis, the price ranges from R$ 130.00 to R$ 155.00. The result is demonstrated in Graphic 1.



Graphic 1 – Energy Sale Price Sensitivity (R$/MWh**)**

The minimum acceptable price for the shareholder is R$ 133.55 per MWh, in order to achieve an IRR of 12% per year, equal to the MARR or Ke. As far as almost all sale prices for biomass projects were closed above this level, the energy sale price assumption is regarded as having a low risk.

6. Conclusion

The construction and operation of a sugarcane bagasse cogeneration plant showed not only a reasonable financial return to the investor but also an appealing low environmental impact, not considering the polemics related to the burning of crops before harvesting.

In the energy viewpoint, the large dependency of the hydropower generation in Brazil increases the importance of using this source of energy. The generation based solely in reservoirs brings up some concern, once the global heating has brought substantial changes in the climate, bringing up the need to diversify sources. Rainfall and the sugarcane harvest have complementary seasons, making it an important source of energy during the dry season. Approximately 90% of the sugarcane harvest is concentrated in the Southeast region. Therefore, the cogeneration plants mitigate the need for long distance transmission lines required to connect large consumption centers to generation sources. The three largest Brazilian cities are located in this region: São Paulo, Rio de Janeiro and Belo Horizonte. A shorter transmission line means less energy losses and a lower risk of transmission failure and blackouts. It means an increase in the system reliability, a contribution to the environment with a renewable source of energy and a reduction in the cost of losses.

Furthermore, due to its availability, the use of sugarcane bagasse results in a competitive advantage to the country. The same is not true with other biomass sources like wood, which has a heavy impact on the environment besides offering a lower heat rate. It is possible to say that Brazil has a natural vocation to develop this type of power project.

It has a lower environmental impact when compared with other Brazilian thermal plants, operated with diesel oil, natural gas and coal, once the air pollution is substantially lower and it causes almost no impact to local rivers and the soil.

The positive aspects to the Brazilian economy are related to: (a) labor, due to the employment of O&M technicians; (b) industrial machinery, which technology is available within national companies; (c) government revenues from deductions and income taxes; (d) lower energy cost wheeled to the grid, when compared to fossil fuel thermal plants.

For the sugar and ethanol plants, the energy self-sufficiency from a cogeneration power plant increases their efficiency. It is an important issue to the country, as far as Brazil is the world's largest sugar producer and the world's second largest ethanol producer.

In addition to these benefits, there is a reasonable return to the sugarcane investors, due to the energy surplus generated by the power plant and sold to the national grid or to free customers, increasing revenues and net income. It is important to emphasize that such return did not take into account the substantial benefit reflected by a lower operational risk and the avoided cost due to the sugar and ethanol mill electricity self-sufficiency.

This study considers the technology currently available, through a business model widely adopted by sugar and ethanol projects. From the model results, we conclude on the project economic feasibility.

This research can be extended by inserting risk analysis and simulation. One example is the impact resulted from a harvest loss. Besides that, the project can be evaluated by considering different types of cogeneration technology, not only restricted to those available but to others that are still under development.

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ANNEX 1 – Income Statement and Leveraged Cash Flow (R$, 000)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Income Statement																					
Energy sale		12.647	13.153	13.613	14.089	14.512	14.947	15.396	15.858	16.333	16.823	17.328	17.848	18.383	18.935	19.503	20.088	20.691	21.311	21.951	22.609
Gross Revenue		**12.647**	**13.153**	**13.613**	**14.089**	**14.512**	**14.947**	**15.396**	**15.858**	**16.333**	**16.823**	**17.328**	**17.848**	**18.383**	**18.935**	**19.503**	**20.088**	**20.691**	**21.311**	**21.951**	**22.609**
Taxes - PIS		(209)	(217)	(225)	(232)	(239)	(247)	(254)	(262)	(270)	(278)	(286)	(294)	(303)	(312)	(322)	(331)	(341)	(352)	(362)	(373)
Taxes - COFINS		(961)	(1.000)	(1.035)	(1.071)	(1.103)	(1.136)	(1.170)	(1.205)	(1.241)	(1.279)	(1.317)	(1.356)	(1.397)	(1.439)	(1.482)	(1.527)	(1.572)	(1.620)	(1.668)	(1.718)
Net Revenue		**11.477**	**11.936**	**12.354**	**12.786**	**13.170**	**13.565**	**13.972**	**14.391**	**14.823**	**15.267**	**15.725**	**16.197**	**16.683**	**17.183**	**17.699**	**18.230**	**18.777**	**19.340**	**19.920**	**20.518**
Fixed O&M		(784)	(815)	(844)	(873)	(899)	(926)	(954)	(983)	(1.012)	(1.043)	(1.074)	(1.106)	(1.139)	(1.173)	(1.209)	(1.245)	(1.282)	(1.321)	(1.360)	(1.401)
Variable O&M		(813)	(845)	(875)	(905)	(932)	(960)	(989)	(1.019)	(1.049)	(1.081)	(1.113)	(1.147)	(1.181)	(1.217)	(1.253)	(1.291)	(1.329)	(1.369)	(1.410)	(1.453)
Transmission Cost		(606)	(630)	(652)	(675)	(695)	(716)	(737)	(759)	(782)	(806)	(830)	(855)	(880)	(907)	(934)	(962)	(991)	(1.021)	(1.051)	(1.083)
ANEEL fee		(48)	(50)	(51)	(53)	(55)	(56)	(58)	(60)	(62)	(63)	(65)	(67)	(69)	(71)	(73)	(76)	(78)	(80)	(83)	(85)
Gross Profit		**9.227**	**9.596**	**9.932**	**10.280**	**10.588**	**10.906**	**11.233**	**11.570**	**11.917**	**12.275**	**12.643**	**13.022**	**13.413**	**13.815**	**14.230**	**14.656**	**15.096**	**15.549**	**16.015**	**16.496**
Insurance		(214)	(222)	(230)	(238)	(245)	(253)	(260)	(268)	(276)	(284)	(293)	(302)	(311)	(320)	(330)	(340)	(350)	(360)	(371)	(382)
EBITDA		**9.013**	**9.374**	**9.702**	**10.042**	**10.343**	**10.653**	**10.973**	**11.302**	**11.641**	**11.990**	**12.350**	**12.720**	**13.102**	**13.495**	**13.900**	**14.317**	**14.746**	**15.189**	**15.644**	**16.114**
EBITDA Margin		**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**	**79%**
Depreciation		(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)	(3.409)
EBIT		**5.604**	**5.965**	**6.293**	**6.632**	**6.933**	**7.244**	**7.563**	**7.893**	**8.232**	**8.581**	**8.941**	**9.311**	**9.693**	**10.086**	**10.491**	**10.908**	**11.337**	**11.779**	**12.235**	**12.704**
Cost of debt		(5.117)	(4.752)	(4.386)	(4.021)	(3.655)	(3.290)	(2.924)	(2.559)	(2.193)	(1.828)	(1.462)	(1.097)	(731)	(366)	0	0	0	0	0	0
EBT		**487**	**1.213**	**1.906**	**2.612**	**3.278**	**3.954**	**4.639**	**5.334**	**6.038**	**6.753**	**7.478**	**8.214**	**8.962**	**9.720**	**10.491**	**10.908**	**11.337**	**11.779**	**12.235**	**12.704**
Taxes - IRPJ		(98)	(279)	(453)	(629)	(796)	(965)	(1.136)	(1.309)	(1.486)	(1.664)	(1.846)	(2.030)	(2.216)	(2.406)	(2.599)	(2.703)	(2.810)	(2.921)	(3.035)	(3.152)
Taxes - CSLL		(44)	(109)	(172)	(235)	(295)	(356)	(418)	(480)	(543)	(608)	(673)	(739)	(807)	(875)	(944)	(982)	(1.020)	(1.060)	(1.101)	(1.143)
Net Income		**345**	**824**	**1.282**	**1.748**	**2.188**	**2.634**	**3.086**	**3.544**	**4.009**	**4.481**	**4.960**	**5.446**	**5.939**	**6.439**	**6.948**	**7.223**	**7.506**	**7.798**	**8.099**	**8.409**
Cash Flow																					
Net Revenue	0	345	824	1.282	1.748	2.188	2.634	3.086	3.544	4.009	4.481	4.960	5.446	5.939	6.439	6.948	7.223	7.506	7.798	8.099	8.409
(+) Depreciation	0	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409	3.409
Working Capital		(205)																			
Installments	0	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	(4.061)	0	0	0	0	0	0
Equity	(16.024)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash Flow	**(16.024)**	**(512)**	**173**	**630**	**1.096**	**1.536**	**1.982**	**2.434**	**2.892**	**3.357**	**3.829**	**4.308**	**4.794**	**5.287**	**5.787**	**10.357**	**10.632**	**10.916**	**11.208**	**11.509**	**11.818**

ANNEX 2 - Payback calculation in the Shareholder Free Cash Flow and Calculation of the Unleveraged Cash Flow (R$, 000)

		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Accumulated cash flow		(16.024)	(16.536)	(16.363)	(15.733)	(14.637)	(13.102)	(11.120)	(8.686)	(5.793)	(2.436)	1.393	5.701	10.495	15.782	21.569	31.926	42.558	53.474	64.682	76.190	88.009
Simple pay-back	**Year 10**																					
Present value of cash flow		(16.024)	(457)	138	449	696	871	1.004	1.101	1.168	1.211	1.233	1.238	1.230	1.212	1.184	1.892	1.734	1.590	1.457	1.336	1.225
Accumulated discounted cash flow		(16.024)	(16.481)	(16.344)	(15.895)	(15.199)	(14.327)	(13.323)	(12.222)	(11.054)	(9.843)	(8.610)	(7.372)	(6.141)	(4.930)	(3.746)	(1.853)	(119)	1.471	2.928	4.264	5.490
Discounted pay-back	**Year 17**																					

FCFC

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
EBITDA	0	9.013	9.374	9.702	10.042	10.343	10.653	10.973	11.302	11.641	11.990	12.350	12.720	13.102	13.495	13.900	14.317	14.746	15.189	15.644	16.114
Taxes - IRPJ	0	(98)	(279)	(453)	(629)	(796)	(965)	(1.136)	(1.309)	(1.486)	(1.664)	(1.846)	(2.030)	(2.216)	(2.406)	(2.599)	(2.703)	(2.810)	(2.921)	(3.035)	(3.152)
Taxes - CSLL	0	(44)	(109)	(172)	(235)	(295)	(356)	(418)	(480)	(543)	(608)	(673)	(739)	(807)	(875)	(944)	(982)	(1.020)	(1.060)	(1.101)	(1.143)
Working Capital		(205)																			
Capex	(68.187)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FCFC	(68.187)	8.667	8.986	9.078	9.178	9.252	9.333	9.419	9.512	9.612	9.718	9.831	9.951	10.079	10.214	10.357	10.632	10.916	11.208	11.509	11.818
WACC		7,6%	7,6%	7,7%	7,9%	8,1%	8,4%	8,8%	9,2%	9,6%	10,0%	10,4%	10,8%	11,2%	11,6%	12,0%	12,0%	12,0%	12,0%	12,0%	12,0%
Present value of cash flow	(68.187)	8.052	7.766	7.269	6.775	6.257	5.741	5.227	4.721	4.228	3.755	3.310	2.898	2.523	2.188	1.892	1.734	1.590	1.457	1.336	1.225