(1) Barrier analysis (Investment analysis and Common practice analysis)

Investment analysis

The construction of a renewable energy plant faces specific financial/economic barriers due to the fact that the capital costs related to biomass units are very high. Additionally, the equipment cost for grid-connected biomass power plants is high. The Project involves construction and installation of a biomass power plant, wherein the biomass boiler alone cost US$ 4.25 million (BRL 9 million); the total Project cost is US$ 8.9 million (BRL 18.8 million). Although the operating and maintenance costs for biomass power plants are comparatively low and thus increasing their attractiveness in long term, this is still insufficient to increase project returns to the level attained by conventional plants. There are no direct subsides or promotional support for the implementation of biomass power plants currently.

Additionally, the capital costs involved in the project pose a barrier, especially considering the high interest rates prevalent in developing countries as well as the difficulties to obtain financing for technologies developed nationally. The project faced difficulties to obtain funding: it took two years of negotiation in order to fund 80% of the capital cost from the National Bank of Social and Economic Development (BNDES). BNDES is the only bank in Brazil that usually funds such risky type of project; it required guaranty such as equipment and other properties. The required guaranty has to be at least twice the value of the financed amount. At that time, BNDES did not have a specific credit line for financing projects using technology developed within Brazil, so it was more difficult at that time to obtain such fund; recently BNDES has launched such credit line.

The analysis of the project finances shows that the project activity would not be economically feasible under such circumstances. Table 1 summarizes the key indicators for IRR-calculations over a period of 10 and 21 years. The IRR without CERs is very low, making the project not attractive for the investors (developers) even over the period of 21 years. With the additional revenue from CERs selling, the IRR reaches 8.0%. Although this is still low, the value with the revenue from the CERs is much closer to the SELIC rate, which has been falling: 17.47% (2004), 18.95% (2005), 14.66 % (2006), and 11.43% (2007)[1]. The SELIC rate is usually used by investors as a reference for an investment. Projects with IRR higher than the SELIC rate demonstrate their strong financial viability for project implementation. Although the IRR of the project activity is low, the project developer wants to take this project as a way to keep a good environmental image of his business on rice processing, as a way to contribute to improvement of environmental conditions in the region and to contribute to the sustainable development in the region since it can generate jobs.

Table 1. Summary of the investment analysis

Investment	18,000,000 BRL	8,909,000 USD
Equity	20%	
Debt	80%	
Biomass cost (BRL/ton)	20	
Biomass purchased (ton/y)	67,300	
Running and maintenance costs	10	% of the revenue
Gross generation (MWh/y)	35,640	

[1] SELIC - Special System of Clearance and Custody. Source: Brazilian Central Bank, 2007.

In-house consumption (MWh/y)	3,168	
Net electricity sold to the grid or to other company (MWh/y)	32,472	
Electricity price (BRL/MWh)	120	(as of March 2007)
Conversion rate (BRL/USD)	2.11	(as of March 2007)
CER price (USD)	18	
Corporate tax (%)	33	
Depreciation (%)	1	
IRR after tax (without CERs)	**-1.98 % (10 years)**	**6.02% (21 years)**
IRR after tax (with CERs)	**1.42 % (10 years)**	**8.01% (21 years)**

Note: Spreadsheet is attached.

An investment sensitivity analysis is presented in Table 2; electricity price seems to be the factor with the most influence on the IRR.

Table 2. Investment sensitivity analysis: IRR for different scenarios (21years)

Scenario		IRR after tax (without CERs)	IRR after tax (with CERs)
0	Project	6.02%	8.01%
1	Maintenance cost 10% larger	5.83%	7.84%
2	CER price 10% larger	6.02%	8.21%
3	CER price 20% lower	6.02%	7.62%
4	Electricity price 10% larger	7.79%	9.69%
5	Biomass cost 10% lower	6.63%	8.59%
6	Biomass cost 10% higher	5.38%	7.42%

In developing countries, where short-term cost minimization is important, grid-connected biomass power projects do not represent an attractive course of action. The additional revenue from the sale of CERs as shown in Table 1 will increase the Project's return to a more acceptable level, enabling the implementation of the Project. Without this extra source of income, the low return combined with the real and perceived risks involved make the Project unattractive to investors.

Common practice analysis

In the absence of the project activity, the rice husks generated in the Southwest part of Rio Grande do Sul State would be left to decay. More than half of the rice husk generated from rice mills in Rio Grade do Sul State are currently being left to decay in open air and the practice will continue in absence of the Project.

Table 3 shows the application of rice husk for different purposes. The latest CIENTEC's data updates still keep the same ratio between the use and sources of rice husks in the State. The rice husk surplus of 60% is considerable, which are landfilled.

Table 3. Use of the rice husks in Rio Grande do Sul State (Rucatti and Kayser, 2004)[2]

Application	Percentage (%)
1.Destined to grain drying	15.2
2.Destined to steam generation	14.0
3.Used as cement additive	7.0
4.Used for motor power generation	4.2
5.Rice husks Surplus (landfilled)	59.6

Using biomass waste as fuel for electricity generation is not a standard waste management practice in Brazil; especially in Rio Grande do Sul State. As the opposite, usually landfill is the main waste management practice in Brazil.

Moreover, using biomass for power generation is also uncommon in Brazil, as evidenced in Table 4.

The project activity, therefore, is highly unlikely to be the natural choice. The few industries that installed a rice husk power plant in Brazil had done it as a CDM project activity. This is an indication that the biomass power generation is not attractive without the revenue from CERs.

Table 4. Power generation in Brazil (% per fuel source) (National Energy Balance 2005)[3]

	1970	1980	1990	2000	2003	2004
Generation to the grid or to the public						
Petrol-derived fuels	5.0	1.8	1.1	2.9	2.0	2.1
Natural Gas	0.0	0.0	0.0	0.4	2.5	3.8
Coal	2.9	1.8	1.2	2.1	1.4	1.6
Uranium	0.0	0.0	1.0	1.7	3.7	3.0
Hydro	84.0	90.5	91.4	85.6	80.8	79.6
Biomass	0.0	0.0	0.0	0.0	0.0	0.0
Self-generation						
Petrol derived fuels	3.1	2.0	1.2	1.4	1.0	1.1
Natural Gas	0.0	0.0	0.1	0.7	1.1	1.2
Coal	0.1	0.1	0.0	0.1	0.1	0.1
Hydro	3.0	2.0	1.4	1.7	3.1	3.2
Biomass*	1.7	1.8	2.3	3.1	4.2	4.2
Others	0.1	0.1	0.2	0.2	0.1	0.1

* It includes several types of waste, sugar cane bagasse, wood, biomass residual, and other renewable sources.

[2] RUCATTI, Evely Gischkow, KAYSER, Victor Hugo, 2004. Produção e Disponibilidade de Arroz por Região Brasileira. Instituto Riograndense do Arroz. Rio Grande do Sul, Brasil.
[3] Source: Ministry of Mines and Energy

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(2) Sensitivity analysis for GEEA Biomass 5 MW Power Plant Project

Scenario	Descripton	IRR without CERs	IRR with CERs
0	Project scenario	6.02%	8.01%
1	Maintenance cost 10% higher	5.83%	7.84%
2	CER price 10% larger	6.02%	8.21%
3	CER price 20% lower	6.02%	7.62%
4	Electricity price 10% larger	7.79%	9.69%
5	Biomass cost 10% lower	6.63%	8.59%
6	Biomass cost 10% higher	5.38%	7.42%

SELIC rate as of 2007 11.43%
Source: Brazilian Central Bank, 2007

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(3) Fuel Sources for Power generation in Brazil

(% per fuel source)

	1970	1980	1990	2000	2003	2004
Generation to the grid or to the public						
Petrol derived fuels	5	1.8	1.1	2.9	2	2.1
Natural Gas	0	0	0	0.4	2.5	3.8
Coal	2.9	1.8	1.2	2.1	1.4	1.6
Uranium	0	0	1	1.7	3.7	3
Hydro	84	90.5	91.4	85.6	80.8	79.6
Biomass	0	0	0	0	0	0
Self-generation						
Petrol derived fuels	3.1	2	1.2	1.4	1	1.1
Natural Gas	0	0	0.1	0.7	1.1	1.2
Coal	0.1	0.1	0	0.1	0.1	0.1
Hydro	3	2	1.4	1.7	3.1	3.2
Biomass*	1.7	1.8	2.3	3.1	4.2	4.2
Others	0.1	0.1	0.2	0.2	0.1	0.1
Total	99.9	100.1	99.9	99.9	100	100

* It includes several types of waste, sugar cane bagasse, wood, biomass residues and other renewable sources.
Source: National Energy Balance 2005. Ministry of Mines and Energy

(4) Surplus biomass analysis

As part of the biomass used in the project activity will be transported from other localities, PROBEM [1] developed a transport technology for the biomass, called *Disperse Biomass Transport*.(DBT) Aiming to improve the transport efficiency, a biomass compactor is adapted to a truck. This compactor will compact the rice husk from 125 kg/m^3 to 315 kg/m^3, i.e. a compacting factor of 2.5 is obtained. The compactor can compact 40 tonnes of rice husk per hour. According to tests, the compactor will consume 0.3 liters of diesel oil per ton of biomass compacted. Also aiming to improve the transport efficiency and decrease the fuel consumption, the transportation trucks is designed to carry two 40-feet containers in each trip. Each container has an internal volume of $78m^3$ and can carry around 20-22.5 ton of rice husk. With this technology, it is possible to carry at least 45 tonnes of biomass per truck per trip. This technology also made feasible to transport rice husks for a long distance (around 250-300 km each way).

In the absence of the project activity, the rice husks generated in the Southwest part of Rio Grande do Sul State would be left to decay. The production of rice in Rio Grande do Sul State amounts 6.3 million ton in 2003/4 harvest (IRGA, 2006)[2]. Since 22% of the weight of the rice corresponds to husks, there was a generation of 1.39 million ton of rice husks in 2003/4 harvest. Considering only Alegrete City, the rice production was 332 thousand ton in 2003/4 harvest, generating an amount of 73 thousand tons of rice husks. Rice fields occupy an area of 45,000 hectares in Alegrete. More than half of the rice husk generated from rice mills in Rio Grade do Sul State are currently being left to decay in open air and the practice will continue in absence of the Project.

Table 1 shows the application of rice husk for different purposes according CIENTEC. The rice husk surplus of 60% is considerable, thus indicating that will not occur competition use of the biomass. Table 2 presents the total rice husk surplus generation within a radius of 300 km far from the project site; the surplus generation is over 400,000 ton per year of rice husk. Although "Consolidated methodology for electricity generation form biomass residues" (ACM0006) version 05 limits the radius of defining the geographical boundary of the "region" for the surplus biomass analysis to be at least 20km but not more than 200 km, Table 2 includes the data from municipalities within the radius of 300kms from the project site due to the presence of DBT system.

Table 1. Use of the rice husks in Rio Grande do Sul State (Rucatti and Kayser, 2004)[3]

Application	Percentage (%)
1.Destined to grain drying	15.2
2.Destined to steam generation	14.0
3.Used as cement additive	7.0
4.Used for motor power generation	4.2
5.Rice husks Surplus (landfilled)	59.6

[1] Technology PROBEM® – Programa de Biomassa – Energia - Materiais (Materials – Energy – Biomass Programs) which belongs to RM Materiais Refratários Ltda, Lorena, SP, Brazil. The Group Pilecco obtained exclusive rights to use PROBEM® Technology in Rio Grande do Sul State, Uruguay, and Argentina. RM Materiais Refratários Ltda. is a company of the Peixoto de Castro Group (GPC).

[2] IRGA – Instituto Rio Grandense do Arroz: Rice production ranking in different regions. Available online: http://www.irga.rs.gov.br/arquivos/ranking.pdf (retrieved on February 2006)

[3] RUCATTI, Evely Gischkow, KAYSER, Victor Hugo, 2004. Produção e Disponibilidade de Arroz por Região Brasileira. Instituto Riograndense do Arroz. Rio Grande do Sul, Brasil.

Table 2. Surplus generation of rice husk in Southwest and Mid-west regions of Rio Grande do Sul State[4]

Municipality	Rice processing (ton/y)	Rice husk generation (ton/y)	Distance to project site (km)
Alegrete	291,577	64,146	0
Uruguaiana	466,231	102,570	140
Quarai	66,039	14,528	120
Santa Maria	45,940	10,106	218
São Pedro do Sul	19,984	4,396	187
São Gabriel	138,242	30,413	165
São Sepé	107,856	23,728	279
Livramento	60,404	13,288	200
Rosario do Sul	110,072	24,215	100
São Francisco de Assis	18,591	4,090	80
São Vicente do Sul	52,750	11,605	178
Manoel Viana	17,263	3,797	48
São Borja	227,423	50,033	224
Itaqui	311,610	68,554	139
TOTAL	**1,933,982**	**425,469**	0

Notes: For Alegrete, only the amount generated by Pilecco Rice Mill is accounted above. As a conservative measure, the generation by other rice mills in Alegrete is not shown in this table.

The total amount of rice husk available in a radius of 280 km far from the project site corresponds to 425,469 ton/y, which is an amount more than four times higher than the necessary to carry out the project. Therefore, this project will not lead to biomass leakage or scarcity in the region.

Table 3. Surplus analysis

Project	Annual rice husk consumption (ton/y)
GEEA Biomass power plant project (project 1089)	67,320
Minimum (25% surplus)	84,150
Biomass surplus in the region	425,469

This analysis indicates that the amount of biomass to be used is relatively small compared to the surplus existing in the region; therefore it will not lead to a leakage due competing use of biomass.

[4] Source: Rice processing associations in South and Mid-west parts of Rio Grande do Sul State