English Abstract

Brazil relies on about 90% of its electricity to hydropower. However, the share of hydropower decreases markedly in the dry season (about May – November). Decreased generation of hydropower during the dry season is complemented by fossil fuel. On the other hand, Brazil's huge sugar industry harvests sugarcane in the dry season, and generates a large amount of solid waste called bagasse. Bagasse has been traditionally used as a fuel to generate electricity and heat for internal use at the sugarcane processing factories.

However, in the light of the impending energy shortage, there is a possibility to enhance its efficiency of bagasse-based electricity generation, and to provide surplus electricity to the grid. Such electricity would be offsetting fossil fuel electricity, and therefore would contribute to greenhouse gas reduction. This study attempts to identify such projects, and determine its greenhouse gas reduction potential.

Background studies on baseline and additionality were carried out. It was determined that the baseline electricity CO_2 emission factor of 0604t-CO_2/MWh is suitable, since it is based on a detailed study by IEA, and its application to Vale do Rosario project has been successfully approved by the CDM-EB. As regards additionality, this remains to be the most contentious issue in this project. In the light of recent development in bagasse-based cogeneration, three ideas can be proposed, namely;

– Projects approved for PROINFA, a government-sponsored renewable energy programme
– Generation of CER ceases when high efficiency cogeneration is introduced to a certain proportion of sugar mills.
– Establishment of technology benchmark

Two projects were identified in the western region of Sao Paulo state (UNIALCO and ALCOESTE). Such location was deemed suitable in the light of additionality demonstration. The greenhouse gas reduction potential for each project is calculated as follows:

Table 1. GHG reduction potential

	UNIALCO (60kgf/cm^2)	UNIALCO (80kgf/cm^2)	ALCOESTE (60kgf/cm^2)	ALCOESTE (80kgf/cm^2)
Case	1	2	3	4
Installed capacity (MW)	40	61	11	29
Electricity generated (MWh)	153,000	273,000	48,000	144,000
GHG reduction potential	92,412t-CO_2	164,892t-CO_2	28,992t-CO_2	78,278t-CO_2

For ALCOESTE which is expanding its capacity, it was determined that, for introduction of a 60kgf/cm^2 boiler (standard new technology), CDM was deemed suitable for only existing part of the plant, whereas entire project was deemed eligible for introduction of a 80kgf/cm^2 boiler (higher than standard new technology)

Internal rate of return (IRR) was calculated as follows:

Table 2. IRR of the projects

Case	1		2		3		4	
Carbon price	0	5USD /t-CO_2	0	5USD /t-CO_2	0	5USD /t-CO_2	0	5USD /t-CO_2
Asset IRR	9.2%	10.5%	6.3%	7.4%	10.9%	12.3%	7.5%	8.6%
Equity IRR	13.1%	16.0%	7.4%	9.5%	16.9%	20.5%	9.6%	12.0%

Result of the sensitivity analysis is as follows:

Table 3. Sensitivity analysis of the projects

Item	Unit	CO_2 price	Asset IRR	Equity IRR
CER price		0	9.2%	13.1%
		3USD/t-CO_2	10.0%	14.8%
		10USD/t-CO_2	11.8%	19.2%
Electricity price	2.5cent/kWh	0	4.1%	2.9%
		5USD/t-CO_2	5.6%	5.4%
	5cent/kWh	0	15.6%	29.2%
		5USD/t-CO_2	16.8%	32.7%
Initial investment	1500$/kW	0	4.7%	4.5%
		5USD/t-CO_2	5.7%	6.2%
Interest rate	8%	0	9.2%	10.2%
		5USD/t-CO_2	10.5%	12.7%

Potential measures to enhance GHG reduction such as increased operating time, introduction of BIG-GT (gasification turbine), heat provision, introduction of mechanized harvesting coupled with use of harvested trash are deemed unsuitable in the face of safety, increased cost and potential employment loss.

Environmental impact is not deemed to be a problem in the light of its location, nature (efficiency improvement of generation), subjected to EIA regulation of Sao Paulo state and necessary measures such as erection of high stacks and waste water treatment. Local stakeholder involvement is also not problematic in the view of its location, improvement of energy security and no loss of employment.

It was concluded that use of bagasse as a cogeneration fuel to provide electricity to the grid is a hopeful CDM candidate, in the light of its substantial potential (c. 6,000MW), though demonstration of additionality remains an issue since such generation is becoming common among the more entrepreneurial of the sugar mills. A considerable number of mills, however, it can also be said that a considerable number of mills are not in a position to readily enter into such business.

The research team has been cooperating with UNICA (sugar mill organization of Sao Paulo State) as well as UNDP, which oversees much of policy implementation in Brazil. Thus, the research team is currently in a good position to establish a scheme to identify CDM projects and produce PDDs that can gain support of the Brazilian sugar industry and the government. Therefore, continued support towards a fruitful cooperation with an

aim to operationalize the Japanese-Brazilian utilization of CDM is desirable.