Business Case Study

INDUSTRIAL ENERGY EFFICIENCY CAMBODIA (IEEC)

SECTOR: RICE MILLING

Vinh Cheang Rice Company, Kampong Cham, Cambodia

Background

Electricity represents 25% of the total processing costs, reducing substantially Cambodia's competitive advantage and the situation could be worse taking into account the high and volatile oil price. This case study emphasizes the potential, need and benefits for energy efficiency and related GHG emission reduction in Cambodian rice milling sector. Cambodia generates over 2 million tons of rice husk from milling activity and rice mills have sufficient quantity of rice husk to be used as fuel for captive consumption but most of mills use diesel oil for milling resulting in high production costs, GHG and other air emissions. This case study has compiled techno-economically viable energy efficiency options and fuel substitution options and their impact on processing cost and GHG emission reduction.

INTRODUCTION

Vinh Cheang Rice Company, located in Veal Kandeang Village, Thboung Khmom District, Kampong Cham Province, Cambodia is a fairly large sized private own rice milling company and was selected as one of pilot plants for Industrial Energy Efficiency (IEE) project of GEF-UNIDO in 2010. A detailed energy audit was carried out in 2010-2011 and a wide range of potential energy efficiency measures identified were presented to management for the economic, environmental and social benefits of energy efficiency application to encourage their participation and co-financing commitment.

Installed capacity of company has been expanded to 12 ton/hr milling, however, at present actual production is reported to be an average of 6 ton/hr and 60-70 ton per day. Company plans to expand production to 100-120 ton/day in near future.

Company is in advance stage of project implementation of identified EE options and has already installed three gasifiers, generators and distribution channel to replace part diesel oil with a total investment of more than 380,000 US$. Financial and technical evaluation of available offers was done in consultation with the owner due to wide variations in cost of gasifiers from abroad and locally fabricated gasifiers. In addition to

EE option company also has invested 1.1 million US$ in modern milling technology and paddy drying equipments to improve the product quality and yield. It was reported that company has totally so far invested 1,480,000 US$ in implementation of 7 options and one option is under feasibility analysis. Parent company, Nicoline Investment Co. Ltd., also has committed to co-finance of 2 million US$ for cogeneration of 2 MW to share energy for rice milling and rubber refining. In addition, company also plans to expand parboiled rice for export; therefore, it would require steam.

SECTORAL PROFILE

Rice sector is one of the most important sectors of agriculture economy of Cambodia and in 2011 total production of paddy was 8.78 million ton and is projected to increase to more than 10.5 ton by 2020 without additional land for paddy cultivation. Rice sector is identified as priority sector by Royal Government of Cambodia and it is envisaged that by 2015 Cambodia will export over 1 million ton of rice. Therefore, production technologies and production cost need to be optimized to be competitive with rice export countries.

PROJECT OBJECTIVES

The project will aim to reduce electrical energy consumption by replacing inefficient equipments like blowers, pumps, transmission systems, oversized and inefficient electrical motors, variable frequency drives etc.

1. Gasification technology is expected to reduce 70% of D.O. consumption in existing diesel engines.
2. Existing moisture content in paddy is average 30% leading to higher % of broken rice. Paddy dryer will reduce moisture content by 14-15%.
3. Modern rice milling driven by individual motor using electrical energy and its techno-economic viability will be demonstrated.

The developmental objective of this particular case study, therefore, is to establish success case of the demonstration of application of the energy efficiency and improved production technologies in rice milling sector and to create the necessary conditions for the dissemination and multiplier effect in other units in country.

PROCESS DESCRIPTION

Flow diagram of process employed in rice milling is presented in fig.1.

RESOURCE CONSUMPTION

In this case study analysis, additional revenue from improved production technology and reduced moisture content in paddy was accounted. Percentage of increased full grain rice and differential price with broken rice (3 piece) was calculated and presented in Table 1.

Based on the specific consumption of material, energy resources and their comparison with benchmark consumption, energy and related GHG saving potential were carried out including options related to part substitution of fossil fuel with rice husk. The EE potential based on experience of project team and production technology and paddy dryer in consultation with management was worked out during energy audit study followed by brainstorming and is presented in Table 2.

Table 1: Impact of implemented option on additional revenue generation

Type of product	Before EE implementation	After EE implementation	Difference	Additional revenue
Full grain rice (Ton/year)	10,170	13,410	+32%	+1,522,800*
Three piece rice (Ton/year)	7,980	4,740	-40%	-1,134,000**
Broken rice small (Ton/year)	1,560	1800	+15%	+ 48,000
TOTAL	**19,710**	**19,950**	**+ 1.2%**	**+ 436,800**

** Selling price of full grain rice is reported to be 470 US$/ton*
***Selling price of 3 piece rice is reported to be 350 US$/ton and broken rice small pieces as 200 US$/ton*

Table 2: Potential of savings of SEC and GHG emissions

Resources/Emission	Before EE	Target	Savings	Benefits (US$)*
Diesel oil (liter/ton of rice milling) with gasifier	20	6	70%	336,000
Diesel oil (Liter/ton of rice milling) with technology change, paddy dryer and more automation	24	10	58%	336,000
Specific energy consumption with gasifier (MJ/ton)	1,005	419	58%	-
Total yield before technology change	60	65	5%	400,000
GHG emissions (TCO_2 eq./ton rice) with gasifiers	52.6	15.8	70%	-
GHG emissions (TCO_2 eq./ton rice) after technology change and paddy dryer (increased mechanization & 20% energy usage)	65	27	58%	-

Calculations are based on annual production of 20,000 tons/annum of milled rice
**Benefit is calculated based on the existing price of D.O. of 1.20 USD/liter and average rice 400 US$ per ton.*

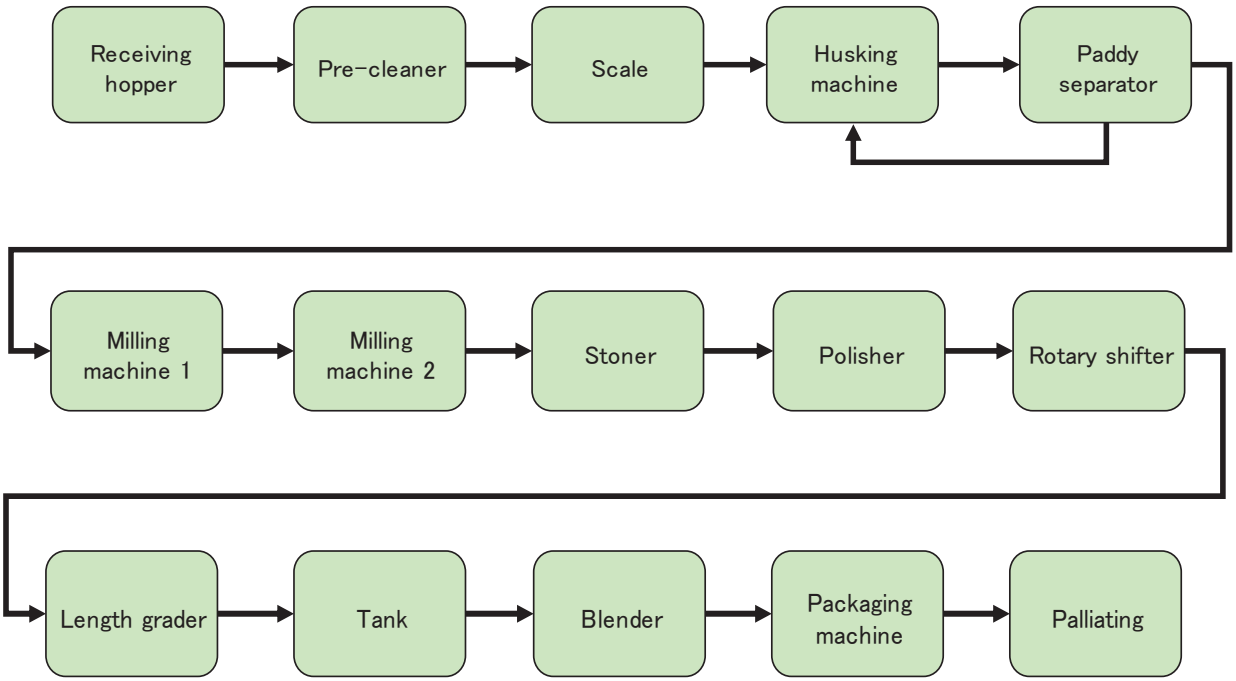

Figure 1: Flow diagram of production process of Vinh Cheang Rice Company

APPROACHES TO RECP AND EE

Company EE team along with project management unit of IEE project collected the baseline data before implementation of EE measures and compiled the data as per the RECP methodology. Initial auditing phase enabled the unit to identify good number of options for energy conservation with attractive financial return and reduction in GHG emissions.

For preparing an implementation plan, EE options were subjected to detailed technical, economical and environmental feasibility analysis. Only techno-economically feasible were selected as energy conservation and fuel substitution solutions for implementation. However, Vinh Cheang company decided to implement production process upgradation options as presented in Table 3 with a high investment of more than 1 million US$. Another high cost option for co-generation of 2 MW power and steam is under consideration and international expert visited company and identifying the suitable technology and supplier. As CP-EE is a continuous process, more options will be identified in next phase of audit based on and future production pattern and availability of by-products.

ENERGY EFFICIENCY AND FUEL SUBSTITUTION SOLUTIONS

A total of 10 EE/fuel substitution measures were identified during the 1st phase of audit and after pre-screening, 8 were selected for detailed feasibility analysis (Table 3) and subsequent implementation of techno-economically viable and environmentally desirable energy efficiency solutions. Till compilation of this report, 7 options with a total investment of 1,480,000 US$ has been implemented.

Table 3: EE measures selected for detailed feasibility analysis

No.	Measures selected for feasibility analysis	Remark
1.	Power generation using duel fuel generator (70% producer gas and 30% diesel oil) to substitute 100% Diesel engine. Major equipment installed: a) 2 gasifiers of 600 kVA and one gasifier of 200 kVA with gas cleaning system b) 3 duel fuel generators 1250 kVA	Already implemented
2.	Install 2 MW co-generation plant using rice husk for electrical and future steam requirement for parboiled rice for export	DPR in progress and technology suppliers are contacted for vendor selection
3.	Installation of paddy rice dryer using hot air from direct rice husk burning to improve the quality of milled rice, to increase the yield, and to increase the shelf life of milling rubbers	Already implemented
4.	Installation of automatic rice silo storage system to reduce the productivity and to reduce the labor cost	Already implementation
5.	Installation of electrical pneumatic rubber roller husker with vibrating cleaning sieve to increase the milling efficiency and to shift single driving belt milling machine to motor driven milling machine	Already implemented
6.	Installation of a new high efficient milling machine to increase the production to 12 ton/hr	Already implemented
7.	Wastewater treatment and recycle system for gasifier	Already implemented, however company is looking for dry ash handling system
8.	Cooling tower for recycling water for gasifier	Already implemented

Table 4: EE measures implemented with investment

No.	Energy efficiency measures implemented	Investment (US$)
1.	Power generation using duel fuel generator (70% producer gas and 30% diesel oil to substitute diesel engine. Major equipments installed are: a) 2 gasifiers 600 KVA and one 200 kVA with gas cleaning system b) 3 Duel fuel generators 1,250 kVA each 360 kVA	 110,000* 180,000
2.	Installation of paddy dryers with shed using hot air from direct rice husk burning	700,000
3.	Installation of rice milling line of 12 ton/hr with individual motors	400,000
4.	Electrical transformer, cabling and distribution	90,000
	TOTAL INVESTMENT	**1,480,000**

** Land cost is not included in investment*

Company participated in 2007 in cleaner production project of UNIDO/CCPP and implemented options related to material and energy consumption. Since company management was already aware of benefits of CP-EE, therefore, agreed to participate and co-finance economically viable EE measures. Some measures were evaluated to be attractive and their implementation process started even before approval of the project and most of them have already been implemented without any financial support from project. Results of energy efficiency and production process measures implemented and their financial as well as environmental impact especially GHG emission reduction is presented below in Tables 5 &6.

For implemented energy efficiency and process up-gradation related options, formal criteria like detailed project report with financial engineering, environmental feasibility analysis were worked out with technology/equipment supplier and company and techno-economically viable options were selected and discussed with management for implementation.

Table 5: Comparison of energy consumption for the Year 2010 & 2012

Parameters	Year	
	2010	2012
Total annual Production (ton)	10,000	20,000
Diesel oil (liter)	200,000	300,000*
Rice husk (ton)	-	2,000**

** After technology change and paddy dryer SEC has increased by 20% resulting in more D.O consumption*
***After implementation of gasifiers, D.O. is partly replaced by rice husk*

The implemented options during first 12 months (till the compilation of this report) provided an excellent opportunity to demonstrate benefits of energy efficiency in terms of GHG reduction; however, SEC in company was high compared to before EE (as presented in Table 7). Since company installed more energy consuming equipments like paddy dryer and rice milling technology with more automation, therefore
SEC was high and also due to part energy generation using rice husk based gasifier having lower efficiency than diesel oil.

In addition to GHG emission reduction achieved as presented in Table 5 & 6, attractive financial returns were also achieved by implementation of 7 medium and high cost options as presented in Table 8. However, in this case study intangible benefits like reduced environmental impact, improved quality of rice (more hygienic) after paddy drying are not accounted.

Table 6: Specific energy consumption GHG emissions comparison in 2010-2012

Parameters		Diesel oil	Rice husk	Total
Spec. Ene. Cons. in 2010		20 Liter 24 Liter*	-	-
	MJ	1005	-	1005
GHG emissions	kg	65	-	65
Spec. Ene. Cons. in 2012*		15 Liter	100 kg**	
	MJ	628	1,340	1,968
GHG emissions	kg	39.5	---	39.5

**SEC per ton of milled rice with paddy dryer and new technology with more automation and low efficiency of rice husk based gasifier*
*** For 1 ton of milled rice 75 kg of rice husk for gasifier and other 25 kg for paddy drying is reported.*

(a) (b)

Figure 2: Captive power generation (a) Three sets of gasifier and gas cleaning system (b) Duel fuel D.G sets

Table 7: Energy efficiency and GHG reduction achieved

Parameters	2010	2012	Saving/ ton	% Savings	Saving (T/Year)
SEC (MJ/ton rice)*	1,005	1,968	-963	- 95%	-
GHG Emissions (kg)	65	39.5	25.5	39%	510

** Increase in SEC is due to extra energy required for paddy drying, automation leading to reduced labor costs and RH based gasifier having low generation efficiency*

Table 8: Economic analysis of implemented and to be implemented options

Parameters	2010	2012	Savings	Total (US$/year)
D.O. (US$/ton)	28.8	18	10.8	216,000*
Increased selling price due to higher yield & % of full grain rice	Nil	2.9	2.9	436,800**
Rice husk used for gasifier and paddy drier (US$/ton)	Nil	2.0	-2.0	- 40,000
Total			**28.8**	**612,800**

**Current annual production of 20,000 ton*
***Average of 2% additional recovery of rice is reported after installation of dryer and (100$/ton is average different in selling price of full & broken rice)*
The investment was very substantial and overall simple payback period on investment and direct savings is over 30 months. The overall results of implementation are compiled and presented in Table 9.

Table 9: Results of IEE pilot project at a glance

No.	Items	No. of Value	% share
1	Total No. of EE options identified	10	
2	No. of EE options selected for feasibility analysis	8	80%
3	No. of EE solutions implemented	7	70%
5	No. of EE solutions requiring detailed technical and financial details	1	10%
6	Savings in energy resource cons./year - Diesel oil (US$) - Revenue from improved quality (US$) - Rice husk used for gasifier and dryers (US$)	 216,000 436,800 -40,000	 39% 2.9%
7	**Total GHG emissions reduction achieved (Ton/year)**	**510**	**39.0%**
8	**Direct savings reported**	**612,800**	
9	**Total investments in US$**	**1,480,000**	**Pay back 30 months**

CONCLUSION

The implementation of the energy efficiency measures has contributed significantly to reduce processing cost, improved working condition, reduce labor cost due to mechanization, better product quality (more hygienic quality of rice), reduced %age of broken rice leading to profit margin improvement as well as reduced GHG emissions. Company is satisfied with the results so far and ready to implement another high cost 2 MW Co-generation for rice mill and other group company for rubber refining. Co-generation option is under advance stage of feasibility study and vendor selection and is envisaged to be implemented in 2nd phase of project.

FOR MORE INFORMATION PLEASE CONTACT:

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